Chapter 3

# The Key Challenges Facing Western Water Managers

Chapter 2 described how the West has been changing and the forces that are affecting both the water resources and the way water is managed. The pressures of rapid population growth and changing economies, coupled with degraded aquatic systems and unmet tribal water rights and needs, present western water managers with considerable challenges for achieving sustainable water use. This chapter analyzes the challenge of sustainable water management, exploring the range of options water managers may want to consider for the future.

## *Sustainable Water Management: The Overall Challenge for the Future*

The Western Water Policy Review Advisory Commission's central message is that all of the West's available water supplies must be sustainably managed to ensure that adequate resources are available for future generations. Water managers face the challenge of devising sustainable use strategies that both accommodate consumptive demands and maintain the essential geomorphic and ecological functions of hydrologic systems. This will require, among other things, a fundamentally new approach to governance.

The Commission focused its efforts on the ultimate questions: "Are the current uses of water and water-related resources sustainable and, if not, what institutional changes will enhance sustainable management?" Sustainable development is a difficult concept to define and no consensus definition exists (Meyers and Muller, 1988).[1] There is, in fact, debate about the utility of the concept as a basis for water policy. Nonetheless, the Commission chose to use the concept because sustainability is gaining acceptance as both an international and domestic norm against which to measure resource use choices.

In this report, we use the definition of sustainable development from the 1996 Report of the President's Council on Sustainable Development, which is, "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (President's Council on Sustainable Development, 1996). As applied to water resources, the core idea of sustainable use and development is that all resource management decisions must give adequate weight to accommodating both consumption and conservation as well as to the legitimate role of equity considerations. For example, the major lesson that John Volkman drew from his study of the efforts to balance competing resource demands in the Pacific Northwest is that, "[s]ustainable development requires us to understand that economic need and

[1] See this article for a summary of the debate about the meaning of sustainable development.

environmental consequences cannot be addressed separately. . ." (Volkman, 1997), and this theme runs through this report.

We echo the admonition of the President's Council that "[e]conomic prosperity, environmental quality, and social equity need to be pursued simultaneously" (President's Council on Sustainable Development, 1996). Both internationally and domestically, sustainable development serves as a bridge between the diverse elements of the water use community and provides the basis for common dialogue and problemsolving. As Sandra Postel has written, we need a water ethic that is

> . . .*part of a sustainable development code that entails a wholly new approach to economic progress, one that harmonizes economic goals with ecological criteria* (Postel, 1997).

The challenge for the future is to manage the West's water in a way that sustains both prosperous cities and viable rural areas, allows Native American reservations to participate more fully in the prosperity of the region, and promotes and enhances healthier aquatic ecosystems.

Sustainable water resources management builds on the long tradition of state and federal water management to conserve water and apply it to a wide range of beneficial uses, but the achievement of sustainability also presents new challenges for which past management practices and institutions often provide limited guidance. Water development has been essential to the development and continued prosperity of the West. However, many of our current water management practices are not sustainable. The equity claims of many Native American tribes remain unfulfilled. Unsustainable groundwater mining continues to exist in part of the West. Many of the West's streams are vulnerable to pollution from a myriad of insufficiently controlled nonpoint sources. Many native fish species are near extinction due to a combination of natural factors, altered riverflows, and watershed land use practices. Small communities that have practiced, or are capable of practicing, sustainable resource management are converting their land and water to meet the demands of higher population growth. Current land use practices and flood control policies are inadequate to prevent rising flood damage levels, and they can contribute to the degradation of aquatic ecosystems. In sum, many western water uses are not sustainable, and the path to sustainability poses many difficult challenges.

## Establishing a New Baseline

To achieve sustainable water uses, we need to define hydrologic baselines for individual basins and watersheds that reflect the full range of valued water uses, including ecosystem uses. We also need to include tribal water rights in that baseline. Federal environmental laws provide a rough set of standards against which aquatic ecosystem health can be measured, but they must be supplemented by state, tribal, local, and private initiatives to bring about ecosystem restoration. Interested parties in the basins and watersheds must be effectively empowered to chart a sustainable future by defining resource goals and developing programs to achieve those goals.

There can be no uniform definition of sustainability because the mix of consumptive and nonconsumptive uses and the condition of the aquatic environment differ among the various basins and watersheds. Sustainable water management is inevitably basin and watershed specific and will require different management strategies. For example, some basins may require substantial new water supplies for urban uses, while others may need more water for agriculture. Still others may be more concerned with improving flows for fish and wildlife purposes. These supplies may require new storage capacity, but new water projects are likely to be smaller and selectively constructed.

Nonstructural solutions will be increasingly emphasized as a management strategy for both flood control and the satisfaction of new and existing consumptive and nonconsumptive demands.

In addition to surface flow management, we need to manage our groundwater better to balance withdrawals with recharge over defined time periods and to recognize the interconnection between groundwater pumping and base flows. We also need water prices that reflect the increasing scarcity value of the resource. We need greater investment in aquatic restoration and aquatic species recovery so that sustained biodiversity will be an integral part of all future water policy decisions.

## Building Partnerships for Basin and Watershed Management

The transition from the water project construction era to the era of more effective use of existing water storage and delivery systems has influenced the role of the federal government and the relationship between the federal government and the states. The traditional federal water management agencies still play a major role in western water management, but this authority is now much more broadly shared within the federal establishment. The federal agencies have fewer funds for construction, although in some cases restoration funding is increasing. Federal authority is increasingly regulatory. Agencies often are confronted with the paradox of regulation: agencies must refrain from the full exercise of their regulatory authority in order to maintain their influence with key political constituencies. As an evaluation of the use of Endangered Species Act to induce multispecies conservation plans noted

> *. . .[i]n order for this approach to work, the threat of an endangered or threatened species listing must be close enough to motivate landowners to participate in a voluntary effort to conserve habitat, but not so close that species might actually be listed before the voluntary program can get off the ground* (Welner, 1995).

The federal government has been experimenting with a number of partnerships. Partnership federalism is characterized by federal participation in federal-state-local stakeholder teams that are designed to develop mutually acceptable solutions to problems such as longstanding conflicts between competing entitlement holders. Partnership federalism will be a critical feature of any new basin and watershed governance process. Past attempts to create basin and sub-basin management units have been top-down federal efforts to impose coordinated and comprehensive management along geographic lines—often over the opposition of interested states, water use constituencies, and federal mission agencies. Water and related land uses were subject to separate, rather than integrated, decision processes, and consumptive uses were generally preferred to nonconsumptive ones. The fragmentation of federal agencies with overlapping but different missions often led to gridlock rather than consensus.

## More Players, Less Federal Influence

Today, there is a great interest among water users, basin and watershed communities, other stakeholders, and government agencies in the creation of new river basin and watershed governance mechanisms. Sustainable water management will require new institutions at the basin and watershed level that can resolve problems with less reliance on large federal investment or involvement. The role of water and the institutions that manage it have been changing rapidly in the past two decades because of an expanding list of uses that now compete for available supplies, and because of governmental and nongovernmental interests that seek a place at the table where important water management decisions are made. One of the most striking changes between water

resources management at the end of the 20th century and water management at the time of the last national commission in 1973 is the increase in the number of players and the diffusion of legal authority and political power among the players. Through the 1970s, state water agencies interacted with the two major federal water development agencies to allocate the West's rivers. The public was primarily concerned with the delivery of reliable supplies of water for major consumptive uses, along with the assurance of adequate instream flows for power generation. Less attention was given to how the water was used by the end user and the consequences of that use.

For these reasons, sustainable water management requires that past policies, institutions, and practices be modified to include government, users, and other stakeholders in important decisions about how water will be used. We agree with the conclusion of the President's Council on Sustainable Development (1996) that sustainable development requires movement away from sole reliance on command and control to more inclusive, experimental forms of governance:

> *Partnerships and collaborative decisionmaking must be encouraged and must involve all levels of government, business, nongovernmental organizations, community groups, and the public at large*.

Partnerships are a source of shared responsibility. There is a need to turn water issues from zero- to positive-sum games, to mobilize public and private collaborative efforts, and to find ways to mobilize new sources of public and private investment in the solutions to water management problems.

The Commission views sustainable development as an ongoing, inclusive, basin- and watershed-based process that adapts general norms, reflected in the general principles adopted in this report, to specific basins and watersheds. To do this fairly and effectively, we need new governance processes that better enable the federal government to both lead and support state and local sustainable development initiatives. The Commission concluded that sustainable development can only be achieved in the context of a new vision of river governance which combines both top-down and bottom-up management. Once basin standards have been set in the appropriate forum, implementation of these standards should be accomplished at the lowest level at which authority and responsibility can be exercised effectively.

The core challenges western water managers face in achieving sustainable use of the West's water resources are:

. 1. The sustainable use of existing supplies: balancing consumptive and nonconsumptive uses of existing water resources, including the problem of overallocation of supplies, groundwater overdraft, the augmentation of supplies, and using supplies more efficiently.

2. Modifying operation of existing federal projects to better address current and future needs.

3. Improving the mechanisms of governance, including linking the management of river basins and watersheds and creating new federal-state relationships.

4. Meeting obligations to Indian nations and tribes.

5. Protecting and restoring the environment, including aquatic ecosystems and water quality.

6. Protecting productive agricultural communities.

These challenges are discussed in subsequent sections of this chapter.

# *The Deschutes River Basin Resources Conservancy*

*The Deschutes River Basin is a poster child for the problems and opportunities associated with the 1990s version of settlement of the West. Its rapid transformation includes several key elements: (1) population is exploding as immigrants seek to improve the quality of their working and recreational lives; (2) timber, agricultural, and ranching communities find themselves under assault as longstanding practices are questioned by the Northwest's changing interests and values; (3) many of these new interests and values are ironically driving substantial growth and development in the basin's recreational, residential, and industrial sectors; (4) collapsing Columbia River salmon runs are mirrored in the Deschutes Basin, where ocean harvesting, hydroelectric development, and land use practices have helped push runs to near extinction; (5) the crazy quilt of federal, tribal, state, and private lands presents both problems and opportunities in land management; and (6) despite the adoption of myriad resource plans—42 at last count—important environmental trends continue in the wrong direction* (*Big River News*, 1997).

One effort to protect and restore the fisheries and other natural values of the Deschutes River while supporting sustainable local economies is the Deschutes River Basin Conservancy (DRC). The DRC grew out of an effort by the Confederated Tribes of the Warm Springs Reservation and the Environmental Defense Fund (EDF) to improve riverflows and water quality in the Deschutes River, while seeking to put tribal and other resource industries on a more sustainable basis. In 1992, the tribes and EDF convened the Ad Hoc Deschutes Group (Group), a forum of 14 members representing all economic sectors in the basin. The Group oversaw assessment of basin resources and development of a report describing incentive-based approaches to addressing basin problems.

The Group developed pilot projects to improve the efficiency of agricultural water distribution systems. Half of the saved water was dedicated to instream flows, the rest to farming operations. The Group also leased water for instream flows.

In 1996, the Congress passed legislation authorizing up to $1 million per year in federal matching funds, through 2001, for projects undertaken by the Group, now chartered as a private corporation, the DRC. The DRC's board of directors includes members of the basin's cattle, agricultural, environmental, recreational, tribal, hydropower, and land development communities. In addition, the DRC has members from USDA and Interior, the Oregon Water Resources Department and Fish and Wildlife Commission, and four sectors of basin city and county government (DRC, 1997-98).

The DRC story illustrates an important process: one or two interests begin to work together to address local resource issues; they solicit participation from a wider group of interests and begin to solve some important problems; their positive approach and results attract state, federal, and congressional support, leading to formal recognition and funding. This process is typical. As local groups reach out and garner wider participation and trust, agencies and political leaders realize that these groups can resolve problems the agencies cannot and begin to invest the groups with legitimacy, agency support, and resources. **#**

# *The Sustainable Use of Existing Supplies*

## Overallocation of Surface Water

Sustainable development requires a new balance between consumptive and nonconsumptive uses. This is difficult to achieve because surface supplies often are fully appropriated under state law. However, there is an increasing appreciation of the need to maintain more natural river and aquifer flow patterns to support wildlife and to maintain such landscape functions as upstream floodwater retention and natural filtration. One of the more striking developments in the past two decades is the increased recognition of the importance of nonconsumptive uses. Historically, nonconsumptive uses were what was left over after consumptive demands were satisfied, but their importance is becoming better understood as we try to maintain and restore degraded aquatic ecosystems. We are struggling with the task of accommodating new consumptive water needs with consumptive water uses. We are beginning to define the baseline flows necessary for operative ecosystems.

Full allocation is not an absolute barrier to more integrated water management. The major lesson of the six basin studies done for the Commission is that consumptive and nonconsumptive uses can be accommodated within the framework of existing rights by more inclusive and creative risk-sharing processes. Water users require dependable water supplies, but they have always faced some risk of supply failure. The law of prior appropriation is designed to allocate water in times of shortage, not to guarantee full supplies. Combinations of physical solutions, conservation, and voluntary transfers can sometimes induce parties to accept increased but acceptable and controlled risk levels in the interest of basinwide solutions. In contrast to judicial processes, which continue to approach water rights conflicts as disputes to be resolved by general principles of water law, nonjudicial processes can focus on identifying problems which require comprehensive, widely accepted solutions that share the risks more equitably. The narrow legal decisions produced by adjudication focused only on determining water rights illustrate the need to approach problems from a basin or watershed perspective in order to devise fair and effective solutions.

## Groundwater Overdraft

Achieving sustainable groundwater use is one of the major water management challenges facing the West. This is primarily a state rather than a federal responsibility. Even though it is widely understood that ground- and surface-water resources are interrelated, most states continue to manage ground and surface water by different legal regimes. The majority of the western states administer surface waters under the doctrine of prior appropriation or by a mixed appropriative-riparian system. However, groundwater governance regimes display less uniformity and are typically far less well defined, making it more difficult for states to manage limited supplies.

Some western states subject groundwater use to prior appropriation and make some attempt to integrate the priority of use with surface water rights.

New Mexico, for example, has a long tradition of integrating ground and surface rights. Others do not. Three of the largest groundwater-using states—California, Nebraska, and Texas—do not allocate groundwater by the law of prior appropriation or acknowledge the potential for groundwater uses to deplete surface supplies. The net result is that state laws commonly allow groundwater overdraft—the depletion of an aquifer at a rate faster than the natural rate of recharge. However, as a recent National Academy of Sciences study indicated, "most decisions regarding groundwater

# *The Henry's Fork Watershed*

The Henry's Fork Watershed in eastern Idaho and western Wyoming encompasses 1.7 million acres and more than 3,000 miles of rivers, streams, and canals. High mountain streams and warm natural springs form the headwaters of the Henry's Fork of the Snake River, which flows through deep canyons as it descends to the agricultural land of the upper Snake River Valley. This rich watershed supports 40,000 residents; 235,000 acres of irrigated farms; healthy populations of fish and wildlife, including several threatened and endangered species; and high-quality recreational experiences.

Over the years, the Henry's Fork has been subject to increased and competing demands to meet irrigation needs, hydropower requirements, and instream flow needs for fisheries and recreation. In 1993 the Idaho legislature passed the Henry's Fork Basin Plan to address these issues. As a result of the Plan, new developments such as dams, diversions, and hydropower projects were prohibited on 195 miles of the Henry's Fork and its tributaries. In order to implement the recommendations and achieve long-term goals in the basin, an innovative, consensus-building process was sought to include all parties with interests in the watershed.

In 1993 citizen and agency representatives began to craft a new approach to reconciling watershed issues in the Henry's Fork Basin. The various interests recognized the importance of working together as a rural community to resolve the ecological problems in the watershed and to work toward a sustainable future. In 1994 the Henry's Fork Watershed Council was organized and chartered by the Idaho legislature. The Council is comprised of citizens, scientists, and agency representatives who reside, recreate, make a living, or have legal responsibilities in the basin, thus ensuring a more collaborative approach to resource decisionmaking.

The Council is cofacilitated by the Fremont-Madison Irrigation District and the Henry's Fork Foundation. Council duties include cooperating in resource studies; reviewing proposed watershed projects and basin plans; suggesting implementation priorities; identifying and coordinating funding sources for research, planning, implementation, and long-term monitoring programs; and serving as an educational resource to the legislature and the general public. The Henry's Fork Watershed Fund was established by the state of Idaho to help fund projects in the basin and to defray Council administrative expenses.

Other Council efforts include installing the Buffalo River fish ladder, fencing riparian habitat, cleaning out culverts, investigating the use of hatchboxes on designated creeks to reestablish trout spawning, protecting native cutthroat, determining the feasibility of reconnecting tributaries to Island Park Reservoir, and facilitating recruitment of young fish into Island Park Reservoir. **#**

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This discussion was drawn from http://www.ser.net/~henrys/ council2.htm.

development, use, or protection are made with inadequate attention to the value of groundwater as a source of consumptive use and for the *in situ* services it provides" (National Research Council [NRC], 1997a). The tendency to undervalue groundwater use is magnified because groundwater supplies generally are deemed superior to surface water supplies in terms of public health protection, technical simplicity, economy, and public acceptance.

The tendency to undervalue groundwater presents the following challenges:

- Groundwater is often used in excess of the rate of recharge. Overdraft may be a rational strategy in certain circumstances, but states should engage in a careful analysis of the costs and benefits of the choice.

- The lack of integrated administration of ground and surface water often means that groundwater use conflicts with efforts to maintain base streamflows.

- Most states do not integrate groundwater quantity and quality considerations, although some states are beginning to do so.

- Excessive groundwater extraction can cause subsidence in the land overlying the aquifer.

## Increasing Supplies and Yield

Federal involvement in western water rested on three basic assumptions that have historically driven western water policy:

- Federal water subsidies were necessary to sustain western rural economies.

- Supplies should be augmented wherever necessary to meet new demand.

- Urban and agricultural development should not be limited by water availability.

Today, each of these assumptions is being challenged as unsustainable. These challenges have profound implications for both water law and the federal agencies that have been created to manage a large percentage of the West's waters. Water allocation and management institutions have not adapted fully to the changing conditions in the West, but they are in the process of adaptation. The challenge for the future is to find more sustainable means of meeting the demand for new supplies. Meeting this challenge will require attention to more innovative technologies for storage and conservation, demand management, and increased reliance on water marketing.

### *New Forms of Supply Augmentation*

Sustainable development will be an evolutionary process that will modify existing water supply strategies and add new ones to the policy menu. Supply augmentation is an example of this potential evolution. Sustainable water management may well require supply augmentation to meet both consumptive and nonconsumptive demands, but the number of economically and environmentally feasible engineering and institutional options are more constrained than they were in the past. In addition to traditional instream dams and reservoirs, new options include different forms of storage, such as offstream reservoirs, the conjunctive management of surface water and groundwater through underground storage, and reservoir enlargement. Financing the necessary supply augmentation may be difficult in the future because fewer federal dollars will be available, which may influence the supply augmentation options that are pursued.

### *Water Storage and Conveyance*

Additional storage reservoirs and transmission facilities and the enlargement of existing reservoirs and extension of existing conveyance features will be a part of future water management. For example, Oregon's 1992 water storage principles recognize the role of storage in providing water resource management flexibility and control in the face of increasing demand and seasonal shortages (WSWC, 1997). However, the nature of the new projects will be different from the past. Most western states recognize the need for additional water development to meet future demands, primarily for municipal or industrial use and water quality management, but they also recognize that large projects will be very limited. New storage will be smaller in size compared to past federally constructed facilities, and new offstream surface water storage is more likely to occur than onstream storage.

California now has under construction two new offstream storage facilities—Eastside Reservoir in Riverside County and Los Vaqueros Reservoir in Contra Costa County. The $1.9 billion Eastside Reservoir Project, including the 800,000 acre-foot Eastside Reservoir, will provide a 6-month emergency supply to Metropolitan Water District's service area and a regulated supply to help meet an additional 1.2 million acre-foot (maf) demand in southern California by the year 2030 (Metropolitan Water District, 1997). The Los Vaqueros Project, which includes the 100,000 acre-foot Los Vaqueros Reservoir, is being constructed at a cost of nearly $450 million and will improve the reliability and quality of the Contra Costa Water District's water supply from the Sacramento-San Joaquin Delta (State of California, 1994).

The enlargement of existing facilities may be an economically and environmentally feasible option. The Bureau of Reclamation (Reclamation) has recently completed storage enlargements of existing facilities in Arizona at Theodore Roosevelt Dam and New Waddell Dam. The renovation and enlargement of Theodore Roosevelt Dam were completed at a cost of $430 million and increased the total reservoir capacity nearly 300,000 acre-feet (Reclamation, 1997a). New Waddell Dam, a feature of the Central Arizona Project, enlarged an existing Lake Pleasant Reservoir by nearly 700,000 acre-feet at a cost of approximately $625 million (Reclamation, 1997a).

New water delivery infrastructure is also needed. California recently completed construction of a new water pipeline to deliver nearly 48,300 acre-feet annually to San Luis Obispo and Santa Barbara Counties. This area experienced shortages in dependable water supplies of approximately 120,000 acre-feet annually during the 1980s, which contributed to overdrafting and deteriorating water quality of the groundwater supply (State of California, 1994). North Dakota is supporting distribution of Missouri River water for municipal and industrial (M&I) purposes in water-short areas of the state. Approximately two-thirds of the state's population live in the eastern and northern portion of the state, and this area is experiencing significant growth. These municipal water systems were authorized to offset, in part, the Garrison Diversion Unit, originally authorized as a multipurpose water project to compensate North Dakota for permanent flooding of lands beneath Missouri River reservoirs. Very little of the Garrison Diversion Unit authorized irrigation has been developed, and it has been suggested that the project be changed to a water supply project for municipal purposes (WSWC, 1997).

New Mexico recognizes the need to construct a new pipeline from Ute Reservoir to meet the water supply needs of communities in three counties of eastern New Mexico. Although rapid population growth is not expected in this region of New Mexico, domestic water supply shortages exist because of lowering groundwater levels and deteriorating groundwater quality in the Ogallala

and High Plains aquifers. Use and distribution of a projected average annual 18,000 acre-feet of supply from Ute Reservoir would alleviate water supply deficits in this large area (Reclamation, 1992).

### *Storage and Conjunctive Use of Groundwater*

Groundwater is an important source of new supply in states that have basins where existing use is less than the sustainable yield or where it is possible to store "surplus" surface water underground. The existence of underutilized groundwater basins is, however, not widespread because most groundwater basins are either in balance with local rivers and streams or are currently overused. States will have to rely on a combination of conservation regulation and supply augmentation to bring these basins into balance. Kansas foresees further development of the Dakota aquifer under a management program to guide and limit its development to assure its long-term viability (Western States Water Council, 1997). In the western part of the state, the Agilely aquifer has been the major source of water supplies. The supply, however, has been fully developed in many instances. Utah has established a policy for the management and administration of groundwater in the Weber Delta Sub-Area along the east shore of the Great Salt Lake.

Conjunctive use of ground and surface water is a longstanding policy option that is used in places such as California and Nebraska and is likely to increase elsewhere in the future. Conjunctive use allows the most efficient use of surface flows and groundwater supplies. The stored water both recharges the aquifer and can be withdrawn in years when surface flows are below normal. For example, the Arvin-Edison Storage District in the southern San Joaquin valley solved a water supply problem through conjunctive management. The district had a service contract for Central Valley Project Water, but the supply was interruptible. The district embarked on a plan to percolate surface water into an aquifer during wet years. As a result, between 1966-94, 4 maf were imported into the district, of which 1 maf was percolated into the aquifer. Even after drought-year withdrawals, there was a net recharge of 372,000 acre-feet. In addition, water table levels have stabilized.

In Nevada, Sierra Pacific Power Company (Reno area) and Carson City rely on surface waters in times of sufficient runoff but shift to increased groundwater withdrawals at times when surface water supplies are insufficient to meet demand or when quality is impaired. In essence, this coordinated operation is a mechanism to allow wet-period beneficial use of surface water, permitting the groundwater aquifer to "rest."

Groundwater storage is clearly a significant supply augmentation strategy. The legal and administrative problems often are more complex than surface reservoir construction and management, but the existing constraints on new reservoir construction increase the financial and administrative feasibility of subsurface storage of excess surface water. Further, well-managed recharge projects tend to be lower in cost than surface storage alternatives and often avoid negative environmental impacts. Also, recharge projects can be designed to enhance the environment by including artificial wetland components.

Arizona has begun to place a great deal of emphasis on storing excess surface water underground through artificial groundwater recharge projects. Arizona's underground storage laws afford two opportunities to bank water in aquifers. (See the sidebar "Arizona Groundwater Law," later in this chapter). Direct recharge is facilitated through constructed or managed underground facilities such as (1) constructed spreading basins or injection wells, designed and operated to add water directly to the aquifer, and (2) managed systems that require less construction and add water to the aquifers by infiltration and percolation of surface water slowly

released to natural streambeds. Indirect recharge is accomplished through groundwater conservation programs. By this strategy, farms and irrigation districts can develop a plan to reduce their use of groundwater and, by exchange, receive surface water supplies, such as Colorado River water, to meet their needs. The district accrues a long-term storage credit (that can be held for an indefinite period of time) through the incidental recharge of excess applied irrigation water.

In Nevada, Las Vegas Valley Water District and the city of North Las Vegas each artificially recharge the aquifer by injecting treated Colorado River water. The purpose of these projects is to have enough water available to meet summer peak demands and to bank excess surface water reserves for future use (Western States Water Council, 1997).

In California, the Kern Water Bank was planned to take advantage of available opportunities to store and extract State Water Project (SWP) water in the Kern County groundwater basin. The project was not implemented as originally planned for a number of reasons, including the delays while awaiting resolution of Sacramento-San Joaquin Delta issues. However, the Department of Water Resources (DWR) and local water service districts have successfully implemented several demonstration programs. In 1990, about 150,000 acre-feet of SWP water was stored in groundwater basins in the area; in 1992 and 1997, the districts exchanged about 57,000 and 27,000 acre-feet, respectively, by pumping groundwater for local use and allowing a like amount to be delivered to SWP users. In addition, two of the larger elements of the originally planned Kern Water Bank project, the Kern Fan Element and the Semitropic Element, are being implemented, but by local water districts instead of by the DWR as originally planned. The Semitropic Water Storage District has developed and implemented a groundwater storage program where it will store in the basin underlying the district up to a million acre-feet of water for other water districts. To date, three SWP contractors are storing water under this program. The Kern Water Bank Authority is in the process of implementing a long-term project using the Kern Fan Element property and has already stored water for participating water users.

### *New Engineering Options: Desalinization and Weather Modification*

There are several experimental and proven technological options for supply augmentation that have not been widely used because of legal and physical uncertainties, cost, and public resistance. These include desalinization, weather modification, and reuse of existing supplies. Although use of these techniques has been limited to date, they are becoming a part of a comprehensive water supply augmentation strategy as we look to the future.

Desalinization and treatment of seawater or other brackish water (e.g., agricultural return flows and poor quality groundwater) to remove the salts and make the water usable for agricultural and urban purposes is technically feasible and is receiving increased attention. There is extensive experience in the Middle East with this technology, but application in the United States has been limited and short term, mainly to provide emergency water supplies. In California, desalting is currently limited to small-scale development because of high operational costs associated with existing treatment technologies (DWR, 1992). There are at least nine existing plants with a combined total capacity of about 11,400 acre-feet per year and at least 12 seawater desalination plants in various stages of develop-ment. In Texas, desalting processes of reverse osmosis and electrodialysis have reduced the cost of converting brackish and saline water to fresh water so that these processes are now being used com-mercially at approximately 80 sites (WSWC, 1997). Texas and Oklahoma have constructed facilities to control chloride in existing water supplies and increase the

usable freshwater supply. The Red River Basin Chloride Control Project, when fully operational, will consist of storage and conveyance structures to regulate and divert fresh and usable water around identified salt flats and natural brine springs and control an anticipated 65 percent of the chlorides in the basin that would otherwise contaminate the water supply (WSWC, 1997).

Weather and snowpack modification have been tried for many decades, but legal and physical uncertainties have dampened enthusiasm for these strategies in many states. In most states, basic questions about liability and the right to use the augmented supply remain unanswered by legislatures and courts. However, in Oklahoma, California, Texas, and several other states, weather modification is considered to be an effective and promising water resource management option to increase water supply. Increased interest in enhancing rainfall by artificial means prompted the Oklahoma legislature to pass the Oklahoma Weather Modification Act, while the Southwest Cooperative Program is a joint effort of several agencies to demonstrate cloud seeding technology to increase summertime rainfall in the Southern Plains region (WSWC, 1997). This strategy has been widely practiced in California, where historically 12 to 20 winter cloud seeding projects have been operated each year.

Weather modification has relatively large potential and small cost; however, yield is difficult to measure. A 1993 Reclamation report states that, for the Trinity Watershed in California, the potentially achievable increases range from 64,000 to 113,000 acre-feet for low and high precipitation years—an increase of about 5 percent in seasonal snowpack runoff. The cost of the seeding program is estimated to be about $8.40 per acre-foot. In Utah, a cloud seeding program was operated in portions of 25 counties at an annual cost of more than $400,000 during the 1990-94 period.

A technique used in conjunction with weather modification or by itself, snowpack management is an option that involves controlling vegetation to develop shadows over snowfields that delay snowmelts and water runoff. However, because this option requires participation by an increasingly regulated and declining timber industry, locations for implementation may be limited.

### *Water Importation*

The doctrine of prior appropriation recognizes that the place of need for water may be at some distance from the source of supply. Federal, state, and local interests have initiated small and large water importation projects, and states such as California and Nevada have cast a wide net looking for potential sources of imported supply. Engineers continue to study large import potentials. The political reality, however, is that opportunities for new, large importations of water and transbasin diversions are limited for a combination of fiscal, environmental, legal, and political reasons. Area of origin protections, state and federal environmental requirements, and the increasing concern for instream flow values, in addition to substantial construction costs to build new transbasin diversion and conveyance features, suggest that it is unlikely that additional imported water supplies will be a widespread solution for meeting new demand.

## Using Supplies More Efficiently

### *Reclamation and Reuse*

Western water has always worked hard. Return flows are a major source of supply in basins throughout the West. Other forms of reuse take advantage of the increasing technical ability to treat water for a variety of second uses. The growing acceptance of reuse is illustrated by the increase in

the use of reclaimed wastewater. In 1990, approximately 553,000 acre-feet of wastewater were used, a 25-percent increase from 1985.

The potential of water recycling, or reclaiming and reusing municipal and industrial wastewater, is also a strategy for increasing freshwater supplies. Recycling creates "new" supplies only in areas where wastewater is not being put to further use. The particular advantages of recycling are apparent in Pacific and Gulf Coast states where wastewater is otherwise discharged to the ocean or in states where wastewater is being irretrievably lost to saline sinks. In California, a *Survey for Future Water Reclamation Potential* report indicates that there is potential for accelerating the pace of water recycling in the future, raising the ultimate statewide water recycling to about 850,000 acre-feet per year.

California's reclaimed water quality standards are a model for other states and countries. Basically, the level of stringency varies with the end use. Virtually all disease-causing organisms must be removed before reclaimed water can be used on agricultural food crops and parks, but the standards are progressively less stringent for pasture, golf courses, fiber, forage, and orchard and vineyard crops (Postel, 1997). A recent NRC study has endorsed greater use of reclaimed wastewater (NRC, 1994).

The Reclamation Wastewater and Groundwater Study and Facilities Act of 1992, commonly referred to as Title XVI of Public Law 102-575, directs Reclamation, through the Secretary of the Interior, to conduct a water reclamation and reuse program. The act authorized Reclamation to participate in the construction of five recycling projects in California and Arizona, four of which have been receiving federal funding. In 1996 an amendment to Title XVI, the Reclamation Recycling and Water Conservation Act, added another 18 projects, including 2 research and development projects.

Gray water use is another possible strategy to increase water supplies. Reuse can be simple or sophisticated. Gray water can be captured from sinks, tubs, and laundry facilities and reused for landscape irrigation. Rainwater can be collected from roof runoff and used for landscape irrigation. Gray water use could help reduce the local demand for potable fresh water over the long term. Many population centers in the arid Southwest are located in areas where the climate requires landscape irrigation at least 7 months of the year, so gray water could replace potable water during that time period. In certain places in California, there is the potential to utilize 24 to 36 gallons of gray water per person per day (State of California, 1994).

### *Conservation*

The trend toward greater conservation and reuse of water will increase. Most western states realize that conservation is a way to "stretch" and augment existing water supplies. Conservation is no longer a strategy used in drought emergencies, but a permanent supply augmentation tool for many water users. Water conservation offices, policies, requirements, and guidelines exist in most western states. In the late 1980s, the state of Washington passed legislation establishing policies favoring water conservation as a source of water supply, if cost effective, as compared to new supply development (WSWC, 1997).

Water conservation includes both installing urban and onfarm technologies and landscape practices that use less water and implementing demand management, which includes pricing water to reflect its opportunity cost. Demand management seeks to reduce consumptive uses by providing economic incentives to use new technologies and to adopt new use practices. The National Energy Policy Act of 1992 requires that all new toilets, faucets, and showerheads manufactured for residential use meet national efficiency standards. Many arid western

cities, such as Las Vegas and Tucson, require xeriscaping—the use of native plants adapted to the climate.

Conservation plans and programs have been developed in urban and rural settings based on retrofitting existing fixtures and conveyance, leak detection, and fee structures. Oklahoma has designed the Oklahoma Leak Detection Program to identify causes of energy and water losses that diminish the efficiency and revenues of many rural water suppliers throughout the state (WSWC, 1997).

Agricultural water conservation focuses on improving delivery and application of water in agricultural use. Improved agricultural water practices include irrigation management, irrigation system selection, onfarm ditch lining and piping to minimize seepage and evaporation losses, irrigation delivery, farm delivery measurement, and reporting systems. Canal lining is an activity that focuses on lining earthen canals and regulating reservoirs with impermeable material and/or replacing open canal facilities with piping. Wyoming's city of Casper, the Casper-Alcova Irrigation District, and Reclamation entered into a water conservation agreement in the mid-1980s. Under the agreement, the city invested in water conservation improvements in the irrigation district's conveyance system with the resulting saved water stored in two North Platte River reservoirs for the city's use. The Coachella Valley Water District in southern California is also a model of efficiency with its recently lined canal, underground pipeline laterals, telemetry flow control, and water metering.

Most states recognize the limitations of water conservation, however. Colorado notes that

> *. . .conservation has limited impacts to overall water supply unless the consumptive use is reduced. Conservation can have significant impacts on the timing of when water supplies are available and may result in a reduction of costs to municipal facilities* (WSWC, 1997).

Montana cautions that water conservation may be important in meeting future demands in localized areas, but it is not expected to be a major source of supply. The impacts of water conservation, at least from agricultural uses, need to be carefully examined. In the arid West, many wetlands and wildlife habitat areas, as well as late-season base streamflows, have developed due to the use of irrigation water. Most western states realize that water conservation is likely to play a significant role in providing additional water supplies, but care must be exercised, especially in those areas where conservation would result in diminished return flows.

### *More Accurate Reflection of the Value of Water*

There is a growing argument for a more accurate valuation of water resources as part of any sustainable water policy. Although water is an increasingly scarce resource with a high opportunity cost, it is often undervalued. Sustainable development requires that water be used more efficiently or that the value of new uses, such as *in situ* use, be incorporated into water use decisions (Postel, 1997). As a general matter, proponents of sustainable development advocate eliminating many resource extraction and use subsidies, so that full production costs would be borne by the producer. More sustainable resource use choices would then be encouraged because the incentives for unsustainable practices would be reduced or eliminated. The 1973 National Water Commission broke new ground when it applied basic principles of modern welfare economics to urge that water be more accurately valued because:

> *Those whose use of water yields utility or value in excess of the cost to them of additional water will use more; those whose*

*use of the water costs them more than the utility or value that they obtain will use less. Thus, water will be shifted to where it is most productive in terms of aggregate utility or value to society*.

When water is undervalued, either because the price is partially subsidized or because the opportunity cost is not taken into account in use decisions, careful use of the water is discouraged. This undervaluing contributes to unsustainable uses.

Sustainable development requires new standards to value water and the use of longer time horizons to make the valuation calculations. As a recent NRC committee concluded, the total economic value of water "is a summation of its values across all of its uses" (NRC, 1997b). A recent study of water use in the Lower Colorado River basin concluded that sustainable water use in the basin requires "pricing policies that reflect the true costs of water to particular uses at particular times" (Morrison et al., 1996).

We rely largely on prices to allocate resources because a properly functioning market is an accurate and decentralized indicator of a resource's economic value. Properly priced resources promote sustainable use decisions. In general, the higher the value of a resource, the more careful the use decisions. The problem with water is that water prices have not always been a reliable measure of the value of water. Often the price is subsidized or the price does not include the external costs of using the resource. Polluted irrigation runoff—such as the selenium found in the Kesterson National Wildlife Refuge in the San Joaquin valley of California in the 1980s (NRC, 1989)—is an example of a cost associ-ated with traditional water use that is not fully paid by the water user. Water is also undervalued because we do not generally calculate the full range of services, especially environmental considera-tions, produced by the resource over time. Environ-mental values not reflected in market prices have long been rejected as intangible.

In recent years, many economists have come to accept that resources such as water have nonuse values and that these values should be considered along with traditional commodity values. These are values that people attribute to *in situ* functions, and these are values just like commodity production values. The legitimacy of nonuse values has been endorsed by NRC studies (NRC, 1996a, 1997b) and blue ribbon panels of distinguished economists (National Oceanic and Atmospheric Administration, 1995). However, there is still considerable debate about how they are quantified and whether they should be considered in parity with values reflected in existing markets.[2]

### *Subsidies*

The continued subsidization of the cost of supplying water can undermine the adoption of sustainable development and use strategies. Subsidies distort the value of water by concealing the true cost of providing water to alternative uses and have historically favored consumptive over nonconsumptive uses of water. The failure of water prices to display the true costs of supplying the water, not to

[2] There are many direct and indirect valuation techniques. Those, such as the contingent valuation method (CVM), that ask people what they would be willing to pay to preserve a resource instead of trying to measure consumer spending preferences, are controversial. The methodological problems are formidable. CVM is, however, increasingly used by decisionmakers as a way of getting ballpark figures for nonmarket resource values. CVM calculations of the opportunity cost of alternative uses of water can be dramatic. For example, studies done for Reclama-tion and the Western Area Power Administration to calculate the foregone values of an altered flow regime from Glen Canyon Dam found that "the national nonuse values . . . are about 30 times larger than the foregone power revenues for seasonably adjusted steady flows" (NRC, 1996b). Sustainable development requires (1) the recognition of *in situ* or "off balance sheet" values and (2) the continued effort to calculate these values so that these values can be factored into water use decisions.

mention the social costs of diverting and transporting the water, often encourages consumption and discourages conservation. The President's Council on Sustainable Development proposed that all subsidies should either meet a national need standard or be eliminated.

The 1973 National Water Commission recommended that subsidization of all new irrigation projects should be ended and that acreage limitation should be abolished for all new projects. The Congress increased the limitation from 160 to 960 acres in 1982 but has not addressed the issue of subsidy reduction in future project water deliveries. The 1973 Commission made no recommendations for the transition from subsidized to less subsidized water deliveries. Reclamation faces this future issue since there will be very few, if any, new reclamation projects of the traditional type. Water users have long relied on the expectation that these subsidies will be continued in the future, although the legal obligation of the federal government to continue them is less clear. There is a need to evaluate carefully existing subsidies to determine whether they contribute to or impede sustainable management. Subsidy recapture would be unfair and disruptive at this late date, but there is a case for the gradual withdrawal of future subsidies.[3]

These conclusions also reflect the global assessments of the relationship between irrigation and world food demands. The 1996 World Food Summit in Rome concluded that

> *. . .agricultural growth in the future must come primarily from rising biological yields rather than from area expansion or intensification of irrigation . . . because most fertile lands are already under cultivation, and most areas suitable for irrigation have already been exploited.*

No national case for expanding irrigated agriculture was articulated to the Commission, although eloquent arguments were advanced for continuing the status quo. Market forces have produced a decline in irrigated agriculture in the West and an increase in the Midwest and Southeast. A recent National Academy of Sciences report states the marginal position of irrigation concisely:

> *. . .the value of water in agriculture is generally less than in industrial and municipal uses . . . and because it is so expensive to develop additional water supplies, only the higher-value water uses are likely to be justified economically* (NRC, 1996a).

[3]As discussed by Mecham and Simon (1995), the terms of repayment and water service contracts can be modified by the government under certain circumstances. The best opportunity is upon contract renewal. While congressional action is required to recalculate the overall repayment obligation and to enact sweeping reforms, the Secretary of the Interior typically has the discretion to independently modify some terms—most importantly, the length of the repayment period. While the repayment of most projects is scheduled over a 40-year period, shorter repayment periods can be required. For example, most components of the Central Arizona Project are to be repaid over 15 to 24 years, even though the authorizing legislation called for repayment schedules as long as 50 years. Changing the repay-ment period can dramatically modify the irrigation subsidy: for example, reducing the repayment period from 40 years to 20 years reduces the interest subsidy from 65 percent to 45 percent, given current interest rates. Several opportunities also exist to

(continued...)

[3](...continued)
periodically adjust operation and maintenance rates, which, according to the Reclamation Reform Act of 1982 (P.L. 97-239; 96 Stat. 1261) must be sufficient to cover actual operation and maintenance expenses. Several other provisions in that legislation seek to confine federal water subsidies to small farms, the original focus of the reclamation program. Districts choosing not to comply with the Reclamation Reform Act are to be assessed "full cost" pricing, which includes interest charges for project construction. Many other notable provisions can be found in the recent legislative history of the Central Valley Project, the site of many contract renewal actions in the past decade. Of particular note is the Central Valley Project Improvement Act, which requires federal water users to make payments to cover fish and wildlife restoration efforts (106 Stat. 4706).

The increasing emphasis on the efficient use of water is a major challenge for water management agencies. They must strike a balance among the continued support of the existing agricultural economy, the transition from agricultural to urban and environmental uses, the satisfaction of Indian water entitlements, and the restoration of rivers stressed by the allocation of water to consumptive use. All projections of future irrigation water use show a decline or small national growth rate. The 1989 U.S. Forest Service study, for example, projected a national irrigation growth rate in irrigation water of 0.5 percent from 2000 to 2040 (Guldin, 1989).

Agricultural producers are facing many pressures for change as the food and fiber they produce are marketed in a global economy. International trends affecting demand include the continued rise in world population, increases in per capita gross world product, free trade, and scarcity of water supplies (U.S. Department of Agriculture [USDA], 1997). Grain exports from the United States are projected to increase as a result of world food demands (including growing per capita meat consumption) and the effects of the North American Free Trade Agreement (USDA, 1997). Some contend that conditions unfavorable to agriculture could affect the ability of agricultural producers to fulfill either domestic or foreign needs.

The policy issue raised by this trend is whether federal water policy should be to support the ongoing market-driven transition from agricultural to municipal and industrial and environmental uses, or whether it should insulate some or all irrigated agriculture from the discipline of the market. Two studies released in 1996, the National Research Council's *A New Era for Reclamation* and the Council for Agriculture Science and Technology's *Future of Irrigated Agriculture*, addressed several policy issues. The reports concluded that irrigated agriculture will face increased competition for new supplies, less federal and state support for supply augmentation, fewer subsidies for crops grown by irrigated agriculture, continued groundwater over-drafts, continued public concern for protection of the aquatic environment, global economic competi-tion, and unresolved Native American claims.

### *Confronting the Issues of Pricing*

A major challenge facing western water managers and policymakers is to promote the more efficient use of the limited water supply. In order to pursue the conceptually popular goal of "doing more with less," however, it is necessary to address one of the most controversial and poorly understood issues in the realm of western water: subsidies. The term "subsidy" is generally utilized to describe a type of payment or other valuable benefit conferred upon a specific individual or group by governmental action without expectation of repayment, designed to encourage or perpetuate a specific behavior. The term often carries a negative connotation, applying to those situations in which the benefit received is considered excessive or inappropriate in comparison to the associated cost, and often resulting in distorted price signals, disrupted market processes, and inefficient patterns of resource allocation and use. The policies pertaining to western water allocation and use are frequently labeled as being fraught with subsidies.[4] Reducing or eliminating these subsidies, it is argued, is an essential element of a strategy of improved efficiency. In the context of western water resources, this typically involves modifying charges paid by users for their supply of water, especially from federal facilities. This is a highly controversial and deceptively complicated issue.

[4] For example, Reisner and Bates (1990:7) observe: "The whole system [of western water] encourages inefficient use. Federal water subsidies, hydropower subsidies, crop subsidies, the doctrine of appropriative rights, constraints on water transfers, fixed or declining block rates—a whole gamut of conservation disincentives has given the American West the most prodigious thirst of any desert civilization on earth."

# *Arizona House Bill 2494*

Starting in 1986 and continuing through 1996, Arizona has adopted a series of laws dealing with artificial groundwater recharge. Initial legislation dealt with the regulatory structure for recharge. Arizona Department of Water Resources oversees the permitting of recharge projects and keeps track of the amount of water stored for permit holders. In order to differentiate and protect the stored water for later use, the statutes provide a special accounting system. Credits are tracked by the AMA or groundwater basin where the recharge occurred. The legal character of the water remains what it was when the water was stored. For example, if a party stores excess Central Arizona Project water in 1996 and recovers that water in 2006, the water will still be considered to legally be Central Arizona Project water and not groundwater. The legal distinction is very important in tracking progress toward the safe yield goals and assured water supply requirements. Recharge statutes allow the groundwater aquifers to be used in a manner analogous to a large reservoir by providing for the issuance of long-term storage credits if the stored water can be demonstrated to be surplus to direct use needs. The statutes also allow the aquifer to be used in place of a treatment plant by allowing water to be recharged in one location and then recovered in another location in the same year. This technique, called annual storage and recovery, allows a water user to use a recharge project as an alternative to treating surface water and piping it long distances to the place of use. For accounting purposes, the water recovered from a well again retains its legal character as if the water were used directly. Both annual storage and long-term storage are innovative techniques which integrate the opportunity to store surface water supplies or excess effluent within the groundwater management system created by the Groundwater Code. Over the past few years, nearly 1 million acre-feet have been stored in Arizona aquifers taking advantage of these statutes.

More recent statutes have focused on the creation of institutions for the purpose of recharging water. The Central Arizona Groundwater Replenishment District was created as a mechanism to help meet the assured water supply requirements. If a subdivision or a municipal provider lacks access to adequate amounts of renewable water resources, but did have available an adequate supply of groundwater, then it might want to use the service of the Replenishment District. The District, which is a suborganization within the Central Arizona Water Conservation District, is responsible to purchase and recharge an amount of water equivalent to the amount of water mined by the subdivision. This mechanism allows the District to act as a broker in finding municipal water supplies, which saves both time and money for individual water users. A second water recharging entity was created in 1996 with the formation of the Arizona Water Banking Authority. The focus of the Authority's mission is to purchase excess Central Arizona Project water while it is currently available and store that water in Arizona's aquifers for recovery in times of shortage. Funding for the Authority comes from property taxes, groundwater withdrawal fees, and general tax funds. The Authority is also authorized to enter into interstate agreements with entities in California or Nevada to bank water on their behalf when extra water is available.

In 1994 the legislature enacted a bill which created the Arizona Water Protection Fund. The Water Protection Fund is a multimillion-dollar-per-year grant program to be used primarily for protection and restoration of Arizona's critical riparian area resources. Grants may also be issued for research and water conservation programs throughout the state. The Water Protection Fund is administered by the Arizona Department of Water Resources, but the Fund is overseen by a 15-member commission whose members are appointed by the Governor, Speaker of the House, and the President of the Senate. In 1995, $6.8 million was awarded for projects in 11 counties. Projects were funded to restore high mountain meadows, purchase Central Arizona Project water to maintain riparian and wetland habitat, and recharge effluent to protect perennial streamflow. Grants are awarded through a competitive proposal process with "on the ground" projects emphasized. The funding for the program comes from an annual legislative appropriation and an in lieu tax contribution if water is produced through the water bank for out-of-state beneficiaries. The Water Protection Fund program has been widely cited as an effective nonregulatory approach to natural resources management. **#**

Water in the West is, quite literally, priceless. Whether appropriated directly from a stream or delivered by a federal, state, regional, or local service provider, water is delivered for a fee that primarily reflects the costs of capture and conveyance; the water itself is normally free. This is known as cost-based pricing, an accounting system designed to ensure the financial self-sufficiency of water systems. This philosophy was a foundation upon which the federal reclamation program was established in the Reclamation Act of 1902, which called upon the project beneficiaries—initially just irrigators—to fully reimburse the federal government for construction and operation and maintenance (O&M) costs.[5] This same philosophy can be found in most other public water systems, as well as many other types of public utilities.

Almost immediately, the cost-based philosophy of the federal reclamation program proved to be financially untenable—irrigators simply could not repay these costs. In the 1920s, the Congress began "forgiving" portions of these repayment obligations. Repayment began to be based upon "ability to pay," a principle adopted in the Reclamation Projects Act of 1939 (53 Stat. 1187). The 1939 act also reflected the fact that federal reclamation projects were increasingly being designed to provide more than irrigation water, also featuring components devoted to flood control, hydroelectric power generation, municipal and industrial (M&I) water supply, and recreation. Under section 9 of the statute, the Secretary of the Interior is required to determine which percentage of total project costs should be allocated to each class of beneficiaries and to then establish appropriate repayment contracts.[6] Reimbursable costs include those associated with irrigation, M&I water supply, and hydropower; while nonreimbursable costs include those for flood control, navigation, recreation, and fish and wildlife enhancement.

Several provisions ensure that users of federal irrigation water pay less than would be required under a cost-based scheme (General Accounting Office, 1996). One of the largest subsidies derives from the practice of not assessing irrigators any interest charges on the capital used in construction. The interest subsidy is substantial; for example, the General Accounting Office calculates this subsidy for Oregon's Tualatin Project in Oregon as covering 97 percent of the construction costs allocated to irrigation. Despite the interest subsidy, irrigators have been assessed $7.1 billion in reimbursable costs out of a total of almost $17 billion in total reimbursable costs and $21.8 billion in total construction costs from 133 federal projects with an irrigation component. As of 1994, less than $1 billion had been recovered from irrigators, and in only 14 of 133 projects have irrigators paid, or are scheduled to pay, the full costs allocated to irrigation.

[5] The 1902 act was somewhat unclear about the recovery of O&M costs, only stating that these expenses were to be covered, at least in part, from public land sale revenues collecting in the Reclamation Fund. Legislation in 1914 made the recovery of O&M costs an explicit obligation of project water recipients. Contractors are also typically assessed "replacement costs," which are funds collected to finance the periodic replacement of particularly expensive project equipment (Mecham and Simon, 1995).

[6] Two types of contracts are typically utilized to recoup project costs associated with irrigation: repayment contracts and water service contracts (Mecham and Simon, 1995). A repayment contract, much like a mortgage, assesses a fixed annual charge designed to recover the investment of federal capital over a given time period, normally 40 years. In these arrangements, an additional annual fee is assessed to contractors based on actual O&M costs, which can fluctuate based on water deliveries and other factors. Water service contracts, on the other hand, are delivery contracts extending up to 40 years that charge contractors a per-acre-foot fee based on a calculation combining capital expenses and O&M charges. These contracts also generally specify delivery quantity obligations and terms of contract renewal. Contracts are typically between the Secretary of the Interior (acting through the Bureau of Reclamation) and irrigation districts organized under state law. As of 1995, the Bureau of Reclamation is a party to 865 repayment contracts and 1,980 water service contracts.

One reason that irrigation repayments rarely are sufficient to cover the interest-free construction obligations is a policy known as irrigation assistance, which derives from the practice of setting contract rates based on an ability-to-pay calculation that considers trends in farm income. Approximately three-fourths of all Reclamation projects feature irrigation assistance. Increased charges are assessed against other project purposes, primarily hydropower generation to recover the difference. Ability to pay pricing has been utilized since 1906, reducing reimbursable costs to irrigation by 48 percent (General Accounting Office, 1996). Another significant subsidy can come from congressional chargeoffs (i.e., statutes relieving specific irrigation districts of financial commitments).

Calculations showing significant federal irrigation water subsidies are typically based on a comparison of contract payments versus actual delivery costs. Even greater disparities are revealed if contract payments are compared to two other values closely associated with the economic efficiency concept: market prices and opportunity costs. As a reflection of the marginal value of water in a particular use, market prices are increasingly being advocated as a desirable tool for guiding water allocation and pricing decisions (e.g., Wahl, 1989). While comparisons between cost-based and market-based rates for federal water can be produced, this type of comparison is most typically reserved for discussions of federal hydropower subsidies, as power generated at federal facilities is often sold at levels far below market prices. For example, Driver (1997) estimates that the rates charged by the Western Area Power Administration (Western) over the next 20 years in most regions will, in the absence of fundamental reforms, be roughly half of market rates, potentially resulting in lost public revenues of over $5.7 billion.

The second economic concept is opportunity costs. A consideration of opportunity costs can raise the value of federal water and power prices even higher, as this concept suggests that these resources are best valued by considering the economic return they could generate if allocated to other types of uses. To accurately determine and implement opportunity cost pricing would require removing existing barriers and transaction costs associated with water and power reallocations and would require an elimination of all subsidies distorting price signals. Recent experimentation with increased water and power marketing in the West suggests that additional reforms in this direction will likely discourage irrigation, while favoring M&I water supply uses and many instream uses, including power production, recreation, and environmental restoration. This would not only increase economic efficiency, but would provide a strong incentive for reduced water usage in the irrigation sector. Achieving these efficiency benefits through the reduction or elimination of irrigation subsidies, however, would fundamentally undermine the historic justification of the western reclamation program and would negatively impact many farming communities, suggesting that the true value of water in the West can only partially be understood by the concept of pricing. It is this issue of social value, rather than the narrower concern of economic subsidies, that must ultimately guide public policy decisions.

Reclamation contractors and farmers are not the only beneficiaries of subsidies. Urban consumers have also benefited from utility pricing mechanisms that often deliver water at average rather than marginal costs, so many users are not faced with the full cost of their water use. Some utility managers have long assumed that increases in price will not result in lower use. Water was uniformly priced by block rates rather than by marginal or incremental cost pricing, which reflected the value of supplying the last unit of the resource. Further, as is the case with electric power, water rates for use at peak demands should reflect the value of supplying that amount of the resource at peak demand time.

# *Improving Water Use Efficiency and Fish Passage*

In 1997, the Bonneville Power Administration will fund $88 million in projects in the Columbia River basin to improve conditions for anadromous fish. The following project, implemented a few years ago with other funding sources, illustrates how agencies can collaborate with landowners to improve conditions for fish, while also enhancing their own water operations and reducing costs.

At two farms along Oregon's John Day River, farmers were diverting water into privately owned ditches via three gravel "pushup" dams to irrigate 85 acres of alfalfa. Each diversion had a fish screen maintained by the Oregon Department of Fish and Wildlife. Several times each year, a bulldozer was used to rebuild the diversion dams, a process which destabilized the channel and added sediment to the river. Ditches and fishscreens had to be cleaned of sediment regularly with a backhoe. Salmon had difficulty passing the diversion dams, and the landowners had difficulty staying within their water rate and duty because of ditch losses and application inefficiency.

A cooperative project between the landowners, the Grant County Soil and Water Conservation District, the Oregon Water Resources Department, the U.S. Department of Agriculture Natural Resources Conservation Service, and Reclamation was undertaken to replace the diversion structures with three diesel pumps with modern fish screens, pumping water into a closed pipe distribution system. The agencies provided approximately $90,000 in materials and services, with the landowners contributing $2,400 for installation and agreeing to provide maintenance for 20 years.

The project appears to have been quite successful. Crop gains have been dramatic, up 1 ton per acre, as water is now applied more efficiently. Ditch maintenance costs have decreased by about $5,000 per year. Costs of operation are about $3,500 per year, with cost savings to all parties of about $16,500 per year. Salmon passage is improved, and water turbidity has been reduced. **#**

### *Water Marketing*

Water may be transferred from an existing to a new use, and this longstanding feature of prior appropriation law, now often called "water marketing," is emerging as a major supply augmentation strategy for both urban and environmental uses. The challenge will be to encourage transfers consistent with sustainable development. That is, transfers make sense when they meet new demands and do not impair either the hydrologic baselines necessary to restore and sustain aquatic ecosystems or the rural communities historically dependent on adequate water supplies. Water rights are alienable property rights, although water rights are different than rights in land and other resources. In recent years, the separation of water from land has been seen as a way to reallocate water.[7]

There are constitutional limits, as yet undefined, to using federal and state regulation to reallocate water from new uses, but there are no federal or state constitutional barriers to voluntary transfers. Water marketing has emerged as a major reallocation strategy in response to the new demands in certain states.

Water marketing often responds to the challenges presented by the potentially zero-sum nature of water reallocations and the growing number of parties at the decisionmaking table. Markets promise greater economic efficiency, while avoiding the environmental and economic controversies associated with new water development. Marketing is becoming an invaluable new tool in how the West manages its limited resources.

Water markets also have costs, and markets can hide social and political inequalities. By allowing the market solely to decide the winners and losers of water reallocations, exchanges may result in no added public value once third-party impacts are considered (National Research Council, 1992b). While water markets may be a practical response to the governance problem of gridlock, if improperly structured or inadequately balanced with other interests, they may actually exacerbate problems by allowing water to flow exclusively toward money, by damaging rural and other less influential communities, and by undermining productive agriculture.

Water marketing may take many forms besides outright sales of water. For example, it may be tied to conservation programs. Washington state has legislation which seeks to encourage investment in water conservation. Washington state first enacted an experimental program for the Yakima River basin to produce new water for environmental use and irrigation through increased use efficiency. The state is authorized to finance conservation projects for water user organizations in the basin; in return, the users must convey the conserved water to the state (RCW 90.38.005). This program was extended statewide in 1993. Trust rights (instream rights held by the state) may be created for water saved by state and federal conservation contracts. The right enjoys the same priority as the original water right but is inferior to the original water right unless the parties agree otherwise (RCW 90.42.040(3)).

Transfers also may be temporary. Several states use water banks to allocate water in times of drought as another route to tapping existing water rights. While in any given year a water rightholder may have excess water, the rule that an unused right may be abandoned or forfeited creates incentives to wastewater. Water banking seeks to counter the "use it or lose it" rule by allowing temporary transfers, which do not impair the underlying right, to a "bank." Water banking was pioneered in Idaho on the Snake River and adopted by California during the drought of the late 1980s and early 1990s. In early 1991, California was facing the fifth consecutive year of drought, and major reservoir

[7] Many states permit water rights to be transferred separately from land.

# *Water Transfers: The Large and the Small*

Most observers of western water problems have endorsed, to a greater or lesser degree, the use of water transfers to address the growing water needs of western cities, Native Americans, and the environment. Water transfers, or marketing, allow current holders of water rights (usually farmers or irrigation districts) to sell or lease their water rights to others, who usually put the water to use in a different location for a different purpose. The water "market" allows individuals to profit from these transactions and allows water to move to more valued economic uses (e.g., drinking water for cities) or to needed environmental purposes. Often, public interest groups or state agencies will acquire water rights for instream flows, wildlife refuges, or other environmental needs. Voluntary transfers are both fair and efficient; existing water rightholders receive the current monetary value of their water, and the water is put to a higher valued use.

However, water is both a private and public resource, and the impact of transfers on the stream system and related lands and communities should be evaluated in transfers. Western water laws do not fully reflect the public or community value of water, and debates continue about the wisdom of transferring water from one location or purpose to another. Questions arise about who should approve such transfers, what types of consequences should be considered, who should be allowed to protest a transfer, who should profit, and other issues.

Water transfers vary widely in their size, purpose, and consequences. A small sampling of cases cannot capture the complexity of the various issues involved. However, the two cases sketched here illustrate the range of effects and the challenge of fashioning rules that can govern every size and shape of transfer.

***Buying Imperial Irrigation District Water For Speculative Profit.—***A few years ago, Ed and Lee Bass, Texas oil and real estate billionaires, bought large tracts of farmland in the Imperial Irrigation District in Southern California. As reported by the Wall Street Journal (1997a),

> *They were going to raise cattle. But it became clear, soon enough, that the Basses' real interest was in the perpetual federal water rights conferred with the 40,000 acres they acquired.*
>
> *Seen as a long-term arbitrage play, the strategy goes something like this: Eventually, water supplies for this area of vast urban sprawl and water-hogging agriculture will grow tight; those with the water and the right to sell any surplus, stand to make megabucks.*

According to the *Journal*, the Basses encouraged the irrigation district to pool its surplus water, including theirs, and sell it to the city of San Diego for prices as much as 40 percent less than San Diego currently pays the Metropolitan Water District.
Under the plan, the Imperial Irrigation District farmers would switch to less water intensive crops or implement other conservation measures and sell the water that they now receive for approximately $12.50 an acre-foot to San Diego for prices that start at $200 an acre-foot and climb over time.

After receiving a great deal of media attention and criticism for the potential "windfall" profits they might receive, Lee and Ed Bass sold their land to U.S. Filter Corporation for approximately $250 million in corporation stock. U.S. Filter is the world's largest maker of water recycling and treatment equipment. U.S. Filter Chairman, Richard J. Heckmann, said, "Every place we look, there is rising demand for clean water, but the supply is not getting bigger. We see tremendous opportunities to make some money and do some good" (*Wall Street Journal*, 1997b).

**Acquiring Water for Stream Restoration.** The Oregon Water Trust is a nonprofit corporation founded in 1993 to acquire consumptive water rights from existing users and convert them to instream flows. The Trust made its first acquisition of a permanent water right for Sucker Creek, a tributary of the Illinois River in the Rogue River basin in southern Oregon. Sucker Creek provides important spawning habitat for coho and chinook salmon but can run dry for several miles during the summer due to irrigation diversions. A property owner sold his right to divert 0.16 cubic foot per second of Sucker Creek flow to the Trust for $8,800. Although this water right is small, it has a priority date of 1857 and can represent the difference between some flow versus no flow in Sucker Creek during dry months of the year. **#**

storage was at 54 percent of average. To meet the gap between available supplies and demand, the state created a drought water bank. Emergency legislation was enacted to allow water suppliers the authority to enter into contracts with the bank and to provide that any temporary transfer would not affect the supplier's water rights. The bank played a major role in shifting water from agricultural to urban uses and from seasonal crops to permanent crops during the last years of the drought. (A recent evaluation of the program concludes that it met the objective of providing emergency supplies, but that established procedures for the protection of third-party interests were bypassed (Gray, 1994).)

Land fallowing, a temporary transfer policy for increasing water supplies, is implemented by contract or agreement with growers or water purveyors to purchase a quantity of water currently used for irrigation; in exchange, the seller agrees to reduce consumptive use by an equal amount. Land fallowing may be temporary, idling land only when needed, or permanent; the latter type of land retirement would be necessary to provide a more reliable supply of water regardless of water-year conditions. Modified cropping is a third option for increasing water supplies under the land fallowing strategy. Under modified cropping, a crop with a high water requirement is replaced with a crop using less water, and the freed-up water use is available for other uses. Land fallowing is an option being examined as a means of satisfying the requirements of Central Valley Project Improvement Act in California (Reclamation, 1995).

## Managing Shortages

The West is vulnerable to both short and long periods of drought, which has been defined as a "creeping phenomenon" which has no fixed definition (Wilhite, 1997). Tree ring analysis reveals that the West has experienced prolonged droughts throughout its history, the most recent of which, from 1986-92, severely affected California, Nevada, and other parts of the West. A significant challenge facing western water mangers is the increasing vulnerability of society to prolonged droughts. There are three reasons for this. First, as the demand for relatively fixed water supplies increases, future droughts can be expected to produce greater impacts. Second, the projected effects of global climate change may exacerbate drought cycles because runoff may occur earlier in the water year and evaporation rates may increase. Third, we continue to treat drought as an emergency rather than a systemic risk in arid areas.

Sustainable drought management requires that our traditional response to drought—supply augmentation—has to be supplemented by a variety of risk-based strategies. We must realize that drought is a recurrent feature of the climate of the West. A sustainable drought policy should seek to minimize the damages associated with prolonged, severe droughts by inducing all sectors of water use to take the responsibility to mitigate damages rather than to rely on postdrought compensation.

Drought mitigation can take the form of both short- and long-term responses. Urban water rationing and modest cuts in irrigation deliveries (within the law of prior appropriation and Reclamation's legal duties to deliver project water to contractual beneficiaries) may be sufficient for short-term droughts, but long-term responses require users to decrease their vulnerability to drought. Water users can be induced to reduce their consumption by the installation of cost-saving technologies, by incentives which allow agricultural users to capture and resell all or a portion of any water saved, and by water prices that better reflect the marginal cost of providing the water. More drought-resistant cropping patterns can be adopted, and improved climate monitoring and risk communication employed to allow users to take mitigation steps in anticipation of a drought.

## Modifying Operation of Federal Water Projects

In addition to increasing water supplies by conservation, reuse, and other measures, new supplies also may be made available by changes in the operating patterns of reservoirs. Where consistent with existing project purposes and entitlements, changes in flow release and retention patterns may make more water available when it is needed. The environmental and, to a lesser extent, social impacts of dams are a growing concern in the West. As a recent U.S. Geological Survey paper observes:

> *. . .downstream effects of dams were of little concern during the design and construction of most dams in the United States. Engineers knew that water releases would erode the channel immediately downstream from spillways and power plants; they attempted to calculate the amount of scour to protect the integrity of the dam and its structures. Changes in fish populations were often unanticipated or were not taken seriously. . .* (Collier et al., 1996).

There are several proposals to restore aquatic ecosystems by the removal of dams. A few small dams may be removed in the future, but, in general, ecosystem restoration will generally take place within the framework of the existing infrastructure. Dams have great potential to contribute to ecosystem restoration because they are a source of altered flows and, where power is generated, restoration funds.

Several states see reoperation or management modification of existing storage facilities as a strategy for augmenting supplies. Modifying operations to increase yield involves changes in operating criteria, policies, and agreements that allow greater amounts of water to be delivered to water users, while at the same time meeting the management objectives of protecting fish, wildlife, and habitat and providing flood control. Most states see reoperation activities as a means to increase the efficiency of regulation and distribution of water supplies. Examples include increasing a reservoir's yield at somewhat greater risk to carryover storage from year to year and converting a single-purpose flood control reservoir to a multipurpose facility, including storage. The Amistad-Falcon Reservoir system in Texas has increased water yield by coordinating operations of system reservoirs to reduce evaporation, capturing floodflows normally lost as spills, and reducing streambank losses (WSWC, 1997). In Colorado, the Front Range Metropolitan Water Forum is formulating cooperative approaches to coordinate and integrate the operations of many existing but separate water systems in the Denver metropolitan area. In Oklahoma, allocation of storage and control of reservoir operations to achieve the full potential of river and reservoir regulation will be an increasingly attractive water management option. At Broken Bow Reservoir, the Oklahoma Water Resources Board, Oklahoma State Department of Wildlife Conservation, Southwest Power Administration, and the Corps of Engineers entered into an interagency memorandum of understanding that set temporary conservation pool releases to enhance the downstream trout fishery (WSWC, 1997). In Oregon, the Willamette Basin Reservoir Study will address whether operational changes or modifications in storage allocation are solutions to meeting present and future water resource needs in this basin.

Changes in wet weather reservoir spill management (inflow forecasting) and operational spill management (end-of-season storage levels) for flood control purposes are options that could offer increased water supply (Reclamation, 1995). A change in spring target reservoir storage for Glen Canyon Dam and Reservoir on the Colorado River from full capacity to about 500,000 acre-feet below capacity was a change in operation policy that

resulted in improved operations, reduced the likelihood of reservoir spills, and allowed for more beneficial use of the water supply.

Dams can contribute to ecosystem restoration through reoperation. Reoperation can provide more environmentally sustainable patterns that mimic features of the natural hydrograph. The recent reoperation of Glen Canyon Dam is an example of the potential to revise operating procedures to produce more environmentally sustainable flow patterns. When Glen Canyon Dam was constructed, it eliminated the natural variation in flow that had sustained the canyon ecosystem (generally, annual floods are an integral part of the natural equilibrium of all river systems because flood cycles "are necessary for maintaining channels and replenishing bankside sediments and nutrients") (NRC, 1987). Following completion of Glen Canyon Dam, Grand Canyon beaches eroded, endemic fish were jeopardized by the substitution of colder, clear water for the warm, more turbid natural flow regime, and rafting trips were subjected to pulsating flows from the daily power release cycle. In 1982, Reclamation and Western Area Power Administration began to collect information about these changes (NRC, 1987; 1991) and agreed to conduct an environmental impact statement (EIS) study of the dam's operations (Interior, 1995).[8]

The Grand Canyon Protection Act requires that the Secretary of the Interior operate the dam in a manner consistent with the "Law of the River" and the Endangered Species Act, and "mitigate adverse impacts to, and improve the values for which the Grand Canyon National Park and the Glen Canyon National Recreation Area were established, including, but not limited to natural and cultural resources and visitor use." The act also directed that a new cost allocation be performed for the project if significant changes in dam operations were implemented, under the principle that, while new environmental and recreation needs might require some reduction in project hydropower benefits, those who were financially dependent upon hydropower revenues should not bear the full economic burden of reoperation. The *Operation of Glen Canyon Dam Final Environmental Impact Statement* was filed in 1995, and a new operating regime was subsequently adopted for the dam. The new plan included limits on fluctuations in daily flow, maximum and minimum flows, and an adaptive management framework.

As part of the adaptive management approach, in 1996 Reclamation released high flows from the dam for a period of 7 days (at the cost of some peaking power revenues). Thirty-four scientific studies were performed before, during, and after these test flows to determine the ability of a managed high flow to rebuild critical sediment deposits for beaches and backwater habitat for endangered fish. The experimental flows illustrated that system management does not necessarily require a fundamental change in reservoir operations, and thus reoperation may not be inconsistent with entitlements.

### *Decision-Relevant Science*

The Glen Canyon Dam flow experiment illustrates the need for science-based resource management decisions. Adaptive management must be supported by science, but we need more focused and integrated research. Water resources management has generally been supported by good science, but the research missions of government agencies are not well adapted to produce the science needed to make informed aquatic restoration decisions. Too often, we spend millions of dollars on science that cannot be applied to make the necessary regulatory decisions. The Sacramento-San Joaquin River basin study reported a familiar problem: millions of dollars have been spent on numerous projects that study elements of the ecosystem, but the research

[8] The triggering event was the decision to upwind the dam's generators.

## *AgriMet—An Automated Weather Monitoring System for Irrigation Water Management*

In an effort to improve irrigation water management in the Pacific Northwest, the Bureau of Reclamation operates a network of automated agricultural weather data collection stations called AgriMet that provides information for modeling crop water use during the growing season.

AgriMet's more than 45 automated stations collect meteorological data required to model crop water use, including solar radiation, air temperature, relative humidity, and windspeed. These parameters are sent by satellite to a ground receiving station in Boise, Idaho, where automated crop water use models are run daily to translate local climate data into daily evapotranspiration information for crops grown at each station.

The crop water use information is published daily in newspapers throughout the region and is integrated into various onfarm technical assistance programs throughout the Pacific Northwest by local agricultural consultants, the Cooperative Extension Service, and the USDA Natural Resources Conservation Service. Reclamation also maintains a dial-up computer system accessed by more than 200 registered users for daily crop water use and related agricultural information. AgriMet information is available over the Internet at: http://www.pn.usbr.gov/agrimet and was accessed nearly 1,000 times per week during the 1997 growing season. Use of AgriMet information is resulting in irrigation water application savings. Various agricultural consultants have reported water and power savings ranging from 15 to 50 percent from client bases ranging from 4,000 to 150,000 acres. In some locations, this reduction resulted in real savings of $9 per acre in pumping costs. **#**

—Peter L. Palmer, AgriMet Program Coordinator

has not been integrated. Thus, scientists cannot answer questions that are basic to making sustainable use decisions.

Modern resource management requires the increased production of "regulatory science." Regulatory science is scientific research directed to providing useful information for regulators facing specific choices, rather than to pursuing knowledge for its own sake. The Department of the Interior's proposal to create a National Biological Survey illustrated the focused and law-driven nature of regulatory science. A National Research Council report endorsing the proposed National Biological Survey concluded that "one of the most important uses of the scientific information gathered by the National Partnership [for the Biological Survey] will be to assist decisionmakers in addressing existing biological resource issues and anticipating future ones" (NRC, 1993). We need integrated, long-term research projects to answer specific regulatory questions. Management strategies should change and adapt in response to new scientific information. A recent National Research Council National Academy of Sciences study captures the essence of adaptive management:

> *Adaptive planning and management involve a decisionmaking process based on trial, monitoring, and feedback. Rather than developing a fixed goal and an inflexible plan to achieve the goal, adaptive management recognizes the imperfect knowledge of interdependencies existing within and among natural and social systems, which requires plans to be modified as technical knowledge improves* . . . (NRC, 1992a).

A new applied science, conservation biology, is being developed to provide the information to protect ecosystems from human impacts and to manage them adaptively (Soule and Wilcox, 1980). Conservation biology seeks to develop scientific standards that can be applied to regulatory criteria and then to develop on-the-ground management strategies to meet the standard (Noss and Copperrider, 1994). For example, endangered species protection first requires the determination of an "effective population size" for species viability. After this population is calculated, a habitat reserve system must be designed (that preserves the species), taking into account existing land use patterns and uses. Existing laws and the politics of endangered species protection require only that *minimum* necessary habitats be preserved. Not surprisingly, conservation biology is concerned with the relationship between species extinction and habitat fragmentation (Wilcox and Murphy, 1985).[9] The basic objective is to manage nature to mimic natural systems (Soule and Wilcox, 1980).

### *Hydropower*

The Glen Canyon Dam studies illustrate the way that hydropower generation shapes the operation of dams. The many conflicts on the Columbia River between hydropower production and recovery of salmon populations are also well known. Hydropower, especially the future of hydropower in the federal system, is an important issue because of the substantial benefits produced, the impact of hydropower on system operations, and the key role that hydropower revenues play, helping to fund project investment as well as funding for restoration of the aquatic habitat. For example, power revenues from Glen Canyon Dam provided tens of millions of dollars for the Glen Canyon environmental studies. Similarly, the Bonneville Power Administration (BPA) contributes over $400 million annually from its revenues toward salmon restoration in the Columbia basin.

In its 1973 report, the National Water Commission did not analyze hydropower issues. Nearly a quarter of a century ago, hydropower was viewed as a relatively benign source of inexpensive power.

[9] Provides a good short review of the early literature.

# *The Artificial Glen Canyon Flood of 1996*

Reclamation built and operates Glen Canyon Dam. Since its completion, questions concerning its effects upon the Grand Canyon and Colorado River have been raised. Reclamation, in cooperation with a number of other agencies, states, and tribes, examined operations in an environmental impact statement (EIS) and concluded that dam operations should change to support a number of objectives, including canyon habitat, fisheries, and endangered species management. To support these goals, adaptive management would be applied to the operations and the results monitored.

Creating an artificial flood to mimic natural spring floodflows was proposed to meet operations objectives. Reclamation—working with other agencies such as the National Park Service, the Fish and Wildlife Service, and various states and Indian tribes—scheduled and released such an artificial flood in April 1996. A monitoring program was established to determine if the flood supported the EIS objectives.

The flood tested various hypotheses concerning effects of high flows upon the Grand Canyon ecosystem. Flood effects were closely monitored to test the results against the EIS objectives including increasing sand deposition above the "normal" waterline, flushing non-native fishes, rejuvenating backwater habitats, and protecting existing endangered species, cultural resources, and the existing trout fishery.

Monitoring indicated that considerable numbers and areas of new sandbars were developed by the high flows, and, despite some erosion, a significant number remained at the end of the summer.

The test flows appeared to flush non-native species from parts of the system. However, this seemed to be a short-term effect, and the numbers of non-native species generally rebounded quickly. Some species (the fathead minnow, for example) even appeared to increase in some areas.

Backwater areas also showed mixed results. In several reaches, the backwater areas that remained after the flood were generally larger than before the flood, but fewer in number. Other important existing resources, including cultural resources, endangered species, and trout, were not significantly adversely impacted.

Overall, the test flood demonstrated the effectiveness of testing management options in the real world. The test did not support all of the objectives of the EIS, which is to be expected when attempting to manage any natural system. It did, however, demonstrate the utility of adaptive management and the need to continue to experiment and test management theories. **#**

## *Use of Adaptive Management by Federal Resource Agencies*

Adaptive management is a process of managing toward defined goals in the face of uncertainty. In many ways, this is the essence of managing natural systems. Adaptive management acknowledges that we do not understand all the consequences of our actions and that any attempt to manage a natural system will produce some unexpected results. Adaptive management depends upon carefully monitoring the effects of management actions on the environment, and then using that information to both refine our understanding of the system and to adjust our management plan. The careful setting of long-term goals separates adaptive resources management from management that simply reacts to changing situations. Adaptive management requires a long-term commitment to assess the effects of a management strategy before modifying it to move closer to the goals.

Adaptive management is currently a popular idea in natural resources management. Various texts have described how the process of adaptive assessment and management can help resolve controversial issues and conflicting management directives (Holling, 1978).

Despite widespread enthusiasm for adaptive management within the federal government, it is hard to find examples in western water resources management where adaptive management has been utilized over several management cycles. Many federal agencies are initiating adaptive management programs, but none has applied formal adaptive management long enough to test the concept in the real world of interest groups, politics, changing budgets, and changing environmental conditions.

Some starts are being made. The Northwest Forest Management Agreement is putting logging and forest management plans in place and monitoring their effect on the population of spotted owls, along with other indicators of watershed health. As discussed earlier, Reclamation is initiating a formal adaptive management approach at Glen Canyon Dam.

Some of the longest running examples of adaptive management of natural resources are the big game management programs in the various states. For example, in Colorado, the Wildlife Commission has for years undertaken experimental management programs and monitored their effects on game species. To increase the number of mature bull elk and buck mule deer, the Wildlife Commission instituted an experimental antler point restriction for all hunting seasons. Monitoring herd composition for several years indicated that restrictions for elk increased the number of mature bulls, but that the number of mature buck mule deer actually seemed to decline. As a result, the antler point restrictions on buck mule deer were removed.

(See "Adaptive Management," next page)

***Adaptive Management (continued)***

John Volkman, in his report to the Western Water Policy Review Advisory Commission, has highlighted some of the difficulties of applying adaptive management to rivers in the West (Volkman, 1997). First, trying to experiment in such a complex managed system is fundamentally difficult, if not impossible, because few controls are available and because the impacts of management actions are likely to be less than naturally occurring fluctuations. Correlating observed changes in the system with management actions will be difficult.

Second, it is difficult to support real world funding for an effort where the results are unknown and where long-term monitoring is required to determine a program's efficacy. While this uncertainty exists for management of all natural systems, historically, federal agencies have preferred to make predictions of a project's effects in a planning report, assume the predictions are correct, and then implement the project. Rarely are any significant resources spent on testing the predictions, partly because there are other uses for the funds and partly because agencies may not want predictions proven false. As conditions and political priorities change, it is difficult to maintain budgets for long-term monitoring.

Despite these challenges, adaptive management has potential to help meet the needs of the real world, where our knowledge is limited but action must be taken. Perhaps the best that can be said about adaptive management is that (to paraphrase Winston Churchill), "Adaptive management is the worst way to manage, except for all the others." **#**

Compared to other water and power issues, hydropower was not perceived as a problem.

Perceptions have changed since 1973. Managers of dams have to balance the competing multiple uses of the projects—a task which is becoming increasingly complex. Although most existing Federal Energy Regulatory Commission (FERC) licensed projects were permitted in an earlier era without regard for environmental mitigation, FERC is now expressly required to give equal consideration to other uses of the water.

FERC regulates construction and operation of most of the nonfederal hydropower capacity—roughly 20,000 megawatts (MW). In 1986, the Congress enacted legislation expressly requiring FERC to give "equal consideration" to the purposes of energy conservation and the protection and enhancement of fish and wildlife, among others, when it issues licenses for new dams or relicenses existing facilities. FERC is also required to include other federal agency requirements in licenses and to consider requirements of environmental laws enacted or amended since 1973. Approximately two-thirds of the licenses for nonfederal hydropower capacity in the West expire between 1997 and 2010, thereby creating the obligation to place environmental conditions on the operations of these facilities. It is likely that the owners and operators of the nonfederal facilities will strongly oppose additional conditions on their licenses and will argue that such requirements will impair their ability to operate in a more competitive, deregulated market.

Balancing competing demands for water, increased knowledge about aquatic ecosystems, legal requirements to protect natural resources, changing public values, and the potential restructuring of the utility industry all pose daunting new challenges for water, power, and natural resource managers. A report to the Commission identifies some of the policy questions that hydropower managers face today (Driver, 1997):

*As the electric utility industry is restructured, what are the impacts on the federal hydropower facilities if they are exposed to a competitive environment? To the extent that aquatic ecosystem protection and restoration activities are currently financed, in part, by revenues generated at federal dams, what are the likely consequences for these activities if those facilities have to become competitive in the marketplace?*

*How will the ability of the federal agencies to manage rivers to meet changing public demands (such as for recreation) and to restore aquatic ecosystems be affected?*

*If federal hydropower facilities are privatized, in whole or in part, how can the multiple purposes—irrigation, municipal and industrial water, recreation, fish recovery, and so forth—of these projects be protected? How will ongoing or future mitigation be met, if at all? Who will make the "trade-offs" among the competing demands for water and power, under what conditions and constraints?*

These questions and many others are currently being debated in the Congress and in state legislatures. It is unclear how these issues will be resolved or even how deregulation or privatization will affect the federal projects. Unless great care is taken, the consequences, intended or unintended, could be significant for aquatic ecosystems specifically and for the management of western water resources generally.

### *Power Marketing Administrations (PMAs)*

Federal hydropower facilities in the western United States are constructed and operated by Reclamation, the Corps, and BPA. The 10 largest dams in the United States are in the West. Seven of the 10 dams

were constructed by Reclamation and the Corps. Fifty-five percent of the total hydropower capacity in the West comes from federal dams.

Power is marketed and transmitted mostly by the BPA and Western Area Power Administration. BPA markets power from 29 federal hydropower dams with a capacity of about 20,000 MW, providing about 40 percent of the firm power in the Pacific Northwest. Western markets power from 55 federal hydropower plants with about 10,000 MW of capacity.

Some observers believe that PMAs are attractive and vulnerable targets for defederalization. For example, BPA is under financial stress at this time—in large part due to its obligation to retire its nuclear powerplant debt. Its rates, once a bargain, are somewhat above the cost of alternative power supplies. The salmon recovery efforts cost BPA about $400 million a year. An additional concern for BPA is that many of its power contracts expire in 2001; if these contracts are not renewed, BPA's financial situation will become more acute. The region's governors, following a major review of the system, suggested breaking BPA into two entities—one for transmission and one for hydropower generation and marketing. The governors' review was, in effect, an effort to head off the efforts to privatize BPA.

Western's situation is different. It is less financially precarious, and its contracts begin to expire, on a staggered basis, in 2000. But, as with BPA, some investor-owned utilities and others see the value of the hydropower generated at the large dams as enticing targets for privatization.

The Congress has considered privatizing the PMAs (particularly in the past 3 years) (see next section for more on the privatization as it applies to all federal water facilities). A variety of reasons are given by proponents of privatization, ranging from the argument that private industry can do the job better to deficit reduction, but initiatives for privatization have failed so far.

In the report to the Commission mentioned earlier in this section, Driver reaches the following conclusions and questions about the federal and federally licensed hydropower system:

A. *Hydropower makes a significant contribution to power supplies in the West, especially in the Pacific Northwest where it provides about two-thirds of that region's generation capacity. Policies adopted for hydropower can have far-ranging effects on the region's economy and environment.*

B. *Restructuring does not really threaten the viability of western hydropower, even if hydropower pays its share of environmental costs, except where hydropower sales have been asked to recover costs unrelated to hydropower, in particular, nuclear power plant costs.*

C. *The sales of hydropower by Western are worth billions of dollars when measured against the alternatives available in the western grid. This value now flows almost exclusively to preference power users. Should some of this value flow to achieve other goals, say deficit reduction or environmental mitigation?*

D. *A distant federal agency, the FERC, will be making many of the trade-offs between energy and environmental policies on western rivers in the next ten to fifteen years, especially in the Pacific Northwest. Is this appropriate?*

E. *Interest in privatization of the power marketing agencies (a.k.a. defederalization) has cooled some since 1995, but it will not*

## *The Shasta Dam Temperature Control Device: A New Method for Improving River Conditions for Salmon*

Shasta Reservoir, located at the north end of California's Central Valley, is the largest reservoir in California, storing 4.5 maf of water for agricultural and urban uses. Reclamation's Shasta Dam, along with other dams in northern California, has restricted the range of native salmon which use the upper reaches of the rivers to spawn. This makes the 55 miles of prime salmon spawning habitat below Shasta Dam even more critical to survival of the species. In 1969, nearly 117,000 salmon made the journey to the upper Sacramento River. However, salmon tolerate only a narrow range of water temperature, especially when young. If water temperatures rise above 57.6 ºF, they begin to die. The temperature of the water released from the dam rises during the summer and fall when the reservoir warms. In the 1976 and 1977 drought, thousands of salmon died when water levels reached 62 ºF. The winter-run chinook was declared a federal endangered species in 1989 ;and in the last 3 years, only 2,000 returning adults were counted (*New York Times*, 1996).

Water from the dam is normally released through the hydroelectric plant, whose intakes are not deep enough in the lake to reach the coldest waters. In 1987, Reclamation began releasing water in summer and fall from deeper in the reservoir, which improved downstream conditions for the salmon but required bypassing the powerplant and foregoing electricity production.

In 1989, Reclamation began researching and designing a multilevel intake structure that could take water from many levels in the lake, allowing the temperature of the releases to be closely controlled without bypassing the powerplant. In 1992, the Congress passed the Central Valley Project Improvement Act, which authorized funds for the temperature control device. Twenty-five percent will be paid by the state of California and 37 percent by water and power customers. Construction began in January 1995, and the 250-foot-tall, $80-million device was completed in February 1997 (Reclamation, 1997a).

The temperature control device is an example of the potential flexibility that exists to improve the operations of dams and reservoirs to more closely mimic natural conditions. In this case, the technological fix is quite expensive but was made politically feasible by the legally protected status of the salmon and the desire to maintain the dam's financially important powerplant operations. **#**

*likely disappear. The two main issues raised by defederalization are: Who gets the value of the hydropower systems, as measured by the difference between their cost and the price of power on the open market? And what is the impact on the environment?*

*F. Federal hydropower's debt to the U.S. Treasury is substantial and increasing. And it appears that neither Western nor BPA is making the taxpayer whole. In particular, the American taxpayer is subsidizing power users because neither Western nor BPA is yet repaying irrigation debt in any substantial amounts, contrary to popular perception. Will this arrangement be altered by Congress? Should it be?*[10]

In sum, there are large decisions to make about western hydropower in the years to come, involving difficult tradeoffs and large impacts on the region. In our view, this requires that the public, politicians, and others beyond the inside players learn the issues and stay involved and that appropriate forums remain available for this involvement.

[10] With respect to the conclusion that taxpayers subsidize the Bonneville Power Administration, BPA contends there is a larger context that must be kept in mind. BPA repays some $850 million to U.S. taxpayers each year. In 1997, the agency had refinanced over $7 billion in debt to the U.S. Treasury at existing market interest rates. It has provided, in addition, a $100 million one-time payment to the taxpayer and over $300 million in additional credits to the U.S. Treasury. The ratepayers of the Pacific Northwest have now paid off entirely the government's original investment in Bonneville and Grand Coulee Dams. The federal government retains ownership of the dams, which will continue to produce value well into the next century. Despite the fact that some old loans prepaid by Bonneville were below market interest rates at the direction of Congress, the arrangement whereby ratepayers paid the federal government's capital investments, including interest, has significant benefit to the federal taxpayer.

## Privatization of Federal Water Facilities

In 1993, Vice President Al Gore initiated the National Performance Review (NPR) with the overall objective of making government work better at less cost. As part of the second phase of the NPR (REGO II), Reclamation implemented a program to voluntarily "transfer title of facilities that could be efficiently and effectively managed by nonfederal entities and that are not identified as having national importance (Reclamation, 1997a)." To carry out this program, Reclamation developed policy guidance, *Framework for the Transfer of Title* for the transfer of title to "uncomplicated projects." The framework applies to transfer situations in which outstanding issues and the concerns of the various stakeholders can be readily resolved. It is not Reclamation's intention to transfer large, multipurpose projects, or power generating facilities at this time.

The framework sets forth six criteria which must be met before any project is transferred, as well as additional guidance which applies to the transfer and establishes the valuation of the assets to be transferred. The six criteria are:

(1) The federal Treasury, and thereby the taxpayer's financial interest, must be protected.

(2) There must be compliance with all applicable state and federal laws.

(3) Interstate compacts and agreements must be protected.

(4) The Secretary of the Interior's Native American trust responsibilities must be met.

(5) Treaty obligations and international agreements must be fulfilled.

(6) The public aspects of the project must be protected.

Since the policy was announced in August 1995, Reclamation estimates that approximately 60 districts, out of 592 water districts (involving 191 operating projects), have expressed varying degrees of interest in taking title. In August 1997, Reclamation estimated that serious discussions were taking place with approximately a dozen districts, but no transfers under the Framework policy have taken place for a variety of reasons, including the concerns of potential transferees about assuming liability for facilities and complying with National Environmental Policy Act and other environmental laws, involvement of the public in the title transfer process, and disputes over the valuation of projects.

Moreover, potential transferees have attempted to bypass the Framework process by requesting the Congress to either authorize or direct the sale of a particular project. The Administration, environmental organizations, and in some instances, other affected stakeholders have opposed these attempts to legislatively mandate transfers, in part because many of the bills have waived environmental laws.

The sale of federal facilities to nonfederal owners presents significant challenges to federal agencies, water and power users, other interested parties, and managers of natural resources. The key challenge is to establish priorities among the competing interests. Who are the winners and who are the losers? Ultimately, who will make the decisions concerning management of the water resources and under what conditions?

## *Improving the Mechanisms of Governance*

For many decades, scholars have been arguing that completely and efficiently addressing water and other natural resource areas requires focusing greater attention on institutional arrangements. The processes by which humans manage their interactions with each other and with the natural world have a profound impact on how water problems originate. Water problems are ultimately human problems, resulting from the interaction of the physical environment with the demands and rules imposed by human institutions (Lord, 1984; Mann, 1993). Only recently has this reality become widely understood and embraced. As a result, nonstructural institutional remedies such as demand management (for addressing water and power shortages) and flood plain zoning are increasingly accepted as practical complements to—and often alternatives to—a continued reliance on problem-solving efforts based on further manipulating the physical landscape.

The main challenge to improving decisionmaking and reducing conflict is to find new basin and watershed governance structures that avoid many of the past pitfalls in institutional design. This will not be easy, because the history of past efforts to achieve comprehensive, multiple-objective river basin and watershed management is not encouraging. Nonetheless, the lesson that basins should be managed along hydrologic units remains clear. As a 1992 National Academy of Sciences study concluded:

> *The focus during the early years of this century on the river basin as a unit of planning needs to be reinvented with new goals and new approaches to make it work more effectively than it did in the past* (NRC, 1992b).

While myriad institutional problems exist, two main questions were addressed by the Commission:

1. What is the most useful federal-state relationship to address water management problems, especially at the regional and river basin level? (This is sometimes referred to as the question of natural resources federalism.)

## *More Efficient Funding of Federal Powerplant Repairs*

Reclamation operates several hydroelectric powerplants in the Pacific Northwest, and BPA markets the electricity generated these projects. Repair and maintenance costs for the facilities have been funded through the federal budget process and then repaid a year later by BPA.

Because federal appropriations are uncertain from year to year, the agencies were concerned that there was potential to compromise the long-term reliability of the power system. Employees from both agencies explored creative alternatives to the federal budget process with the objectives of securing the longer-term budget certainty, reducing red tape, increasing management flexibility, and providing costs savings for the ratepayers. The result was the direct funding agreement, executed December 11, 1996, which enables BPA to fund directly those annual operation and maintenance costs of Reclamation power facilities from its power marketing revenues.

The agreement removes approximately $36 million from the federal budget process annually and allows BPA and Reclamation to determine the amount and timing of funds that will ensure the facilities are efficiently operated, repaired, and maintained. In essence, this agreement allows Reclamation to operate "corporately," with budgets driven by the business needs of the two agencies, rather than by the budget process and schedule of Congress. The agreement covers a 10-year period beginning October 1, 1996, and can be renewed indefinitely.

A joint operating committee, composed of representatives from both agencies, will review budgets and program expenditures, measure performance, and determine the level of performance incentives to be provided if Reclamation successfully achieves the performance objectives of each annual power budget.

Unfortunately, this funding mechanism is limited to the Pacific Northwest because the budget authority used is exclusive to BPA. Western, which markets Reclamation and Corps power in other regions, lacks similar authority to enter into direct maintenance funding arrangements. **#**

2. What institutional arrangements can promote effective, inclusive decisionmaking at the local level?

## The Changing Federal-State Relationship

The allocation of governance responsibilities in western water resources between the federal and state governments has always been somewhat problematic, frustrating, and fractious. Strong federal roles in multipurpose water development, management, and, more recently, environmental regulation have evolved in a policy environment which simultaneously stresses state administration of water allocations under a system of privately held water rights. The western states began to determine their own approach to water allocation before the federal government began financing reclamation projects and constructing multiple purpose reservoirs. A new round of tensions has been created by the overlay of federal environmental protection mandates.

We have seen three models of federal-state relations: (1) federal supremacy, (2) federal preemption, and (3) a presumption of shared authority. The federal supremacy model displaces state law with the exercise of federal constitutional authority. Federal Indian reserved rights are an example of this model. Federal preemption occurs when the Congress implicitly or expressly exercises its constitutional authority and decides to displace state law. With some exceptions, FERC's authority to license dams has been interpreted by the Supreme Court to preempt inconsistent state laws.

Traditionally, the western states have resisted assertions of federal authority because state allocation primacy was displaced. The basic constitutional argument is that the federal government separated all water from public lands and thus ceded to the states the complete power to allocate and manage water. In the famous *California Oregon Power* v. *Beaver Portland Cement Co.* decision in 1935, the Supreme Court gave constitutional stature to a history of deference to state water law and policy and provided the constitutional foundation of the primacy of state water law because the decision protects the rights of the states to choose their own allocation systems and to define property rights presumptively eligible for constitutional protection. However, the decision does not immunize the states from the exercise of all federal power relating to water. Prior and subsequent decisions excepted tribal and non-Indian federal reserved water rights from the severance, and states now generally recognize the federal government's power to manage water resources for federal objectives. As the Colorado Supreme Court said in 1983:

> *Federal statutes, as interpreted by the United States Supreme Court, recognize Colorado's authority to adopt its own system for the use of all waters within the state in accordance with the needs of its citizens, subject to the prohibitions against interference with federal reserved rights, with interstate commerce, and with the navigability of any navigable waters (Colorado Department of Natural Resources* v. *Southwestern Colorado Water Conservation District).*

In summary, while *California Oregon Power* continues to be the constitutional foundation of western water law, it does not require that the federal government always defer to state law. *California Oregon Power* requires federal protection of vested rights, but it does not limit the federal government's supreme power to manage resources in ways that conflict with allocations established under state law.

The deference policy worked reasonably well for reclamation programs. The federal government was limited to the assertion of major policies, such as acreage limitation laws, and otherwise the states

could control the allocation of water for Reclamation projects. The deference policy does not work as well for the management challenges that today's western water managers face because many of the major management challenges involve environmental protection. The Clean Water Act, the Endangered Species Act, and the 1986 Federal Power Act Amendments impose national environmental protection mandates on both federal and state water managers. They do not reflect the tradition of deference to state law, and the Congress gave little thought to the impact of these programs on water management in their enactment.

Deference does not excuse the states from compliance with these federal regulatory programs, and thus there is a need to understand the reach and limits of the Supreme Court's presumption of deference to state water law to accurately understand the evolving federal role. This is both the legal and political reality of western water management. While the federal environmental laws do not seek to displace directly state law (as the federal government occasionally did under the Reclamation Act of 1902 and the Federal Power Act), they overlay water rights regimes. In other words, these laws leave state allocation primacy in place but impose additional duties on state water rightholders. Sustainable water resource management would perhaps be better served if both the federal government and the states recognized that each has major, but nonexclusive, management roles, and that the issue is how this mutual authority can be directed through new governance institutions to ensure the sustainability of our river basins and watersheds. Thus, with the notable exception of environmental regulation, federal primacy in many areas of water development and management is giving way to a greater state and nongovernmental role. Contemporary resource management requires multijurisdictional cooperation because no one political jurisdiction can implement the necessary plans and policies, and the growing interest in federal budget deficit reduction is likely to accelerate these trends.

### *Agency Jurisdictions*

The changing allocation of roles among the branches of government has been as significant as the state/federal shift. Most of the federal agencies with significant water and land management responsibilities in the West emerged in an age in which agencies (in all subject matters) were looked to as impartial, scientific decisionmakers, a concept underlying much of the progressive conservation era (circa 1890-1920) (Hays, 1989). Over time, this idea has lost popular support as agencies have increasingly become characterized—sometimes unfairly—as interest groups pursuing agendas of bureaucratic status and growth, responsive only to narrow constituencies seeking federal support for their interest. In a national context, this governance phenomenon is regarded as part of the larger trend of "interest group liberalism" (Lowi, 1979). In the water resources realm, this changing perception of agencies primarily grew out of our national experience with water development "iron triangles"—policy subsystems of federal agencies, key congressional committees, and local interest groups organized to promote particular water projects (McCool, 1994). As the environmental and economic costs of this mode of decisionmaking became more widely understood, and as growing populations placed new and diverse demands on limited natural resources, an era of environmental activism was born, the iron triangles began to weaken, and natural resource agencies increasingly found their actions subject to judicial review. The water resources subject area featuring the greatest growth in judicial involvement has been the intersection of water quality and quantity management, which has historically been viewed as distinct activities (Dinar and Loehman, 1995). As water management issues become increasingly multifaceted, this fragmentation of modern governance arrangements is becoming more problematic.

The enhanced role of the judiciary in issues of water development and management has been accompanied by an enhanced role for environmental activists, Indian tribes, and other parties previously excluded from water decisionmaking systems. After decades of crafting policy in relatively closed and narrowly focused policy arenas, major issues in the water resources realm are now considered in processes that are increasingly open to diverse interests and viewpoints (Ingram, 1990). While certainly desirable from a normative standpoint, this change in our processes of governance has made it increasingly difficult to make decisions, as more and more parties come to the decisionmaking table seeking an increasingly diverse set of benefits from limited western water resources.

Collectively, the inclusion of diverse interests has made the politics of water much more complex. Federal subsidies and the exclusion of divergent interests during the water development era made it relatively easy to craft positive-sum solutions while, in contrast, open processes and the increasingly reallocative nature of modern water issues frequently gives these conflicts a zero-sum quality (Lord, 1979; Ingram, 1990).[11] At least two significant trends have emerged from greater inclusion in water development. First, the incentive for congressional involvement in water disputes is lessened. Disputes that are not clearly resolved by congressional policy choices end up in the courts, further shifting power in the intergovernmental system toward the judicial arena (even though it is often difficult for courts to consider scientifically complex proposals that influence, and are influenced by, other projects and resource management concerns) (Goldfarb, 1993). Second, a growing number of parties involved in decisionmaking have the legal and political resources to influence policymaking efforts, resulting in an increasingly large number of interests with the power to veto, or at least impede, proposed actions. The simultaneous growth in the number of parties with veto power, considered along with the growing difficulty in crafting positive-sum solutions and the largely unmet need to address the interrelationships among resource issues, means that the act of making essential decisions—the primary purpose of all mechanisms for governance—is more difficult than ever. The result is gridlock.

## Collaborative Decisionmaking to Help Break the Gridlock

The gridlock, fragmentation, and related deficiencies in the mechanisms of resource governance have spawned interest in institutional reform. The use of collaborative groups, such as watershed initiatives, is becoming more popular, often out of necessity. As Rieke and Kenney (1997) observe:

> *The 1990s have seen a proliferation of "watershed initiatives," in which stakeholders from a variety of governmental levels and jurisdictions have joined with nongovernmental stakeholders to seek innovative and pragmatic solutions to the problems associated with resource degradation and overuse. Although these initiatives share many common qualities, they are also notable for their variety of structures and functions, a predictable feature given that each watershed initiative is an ad hoc effort tailored to the unique institutional qualities and physical qualities of the particular region.*

[11] In a zero-sum solution, benefits to one party come at the expense of another. Technically, a positive-sum solution is one in which the benefits to all parties exceed the costs to all parties. In such a situation, some individual parties may actually incur more costs than benefits, although the net result for all parties viewed collectively is to benefit. From a political standpoint, the primary concern is normally to ensure that all participating parties receive either net benefits or no change in their condition, a special subset of positive-sum solutions known as Pareto optimal solutions.

Like water markets, watershed initiatives provide a tool for concerned parties to interact and to make decisions (i.e., to govern) regarding issues and resources of mutual concern. Unlike water markets, however, the basic philosophy of watershed initiatives is to involve as many parties as possible in consensus-based decisionmaking processes, with the rationale that any party deliberately excluded from consideration will likely try to exercise its legal and political authorities through other channels to block proposals emerging from the initiative.

This fundamental difference between watershed initiatives and water markets is perhaps best explained by observing the different subjects each typically addresses. Water reallocations, the typical subject matter of water markets, involve redistributing a fixed quantity of water and, as such, have the potential to be zero-sum in nature when all interests are considered. In contrast, watershed initiatives typically do not focus on issues of water supply, but instead focus on broader issues. These efforts typically promise to provide collective benefits to all participating (and even nonparticipating) parties. By bringing a type of pragmatic democracy to hydrologically relevant management units, watershed initiatives appear to be a worthwhile innovation in resource management and governance.

Despite their positive qualities, watershed initiatives have a limited scope of effectiveness because they cannot operate at the scale necessary to solve some broad problems or mobilize the necessary resources to do so. Ironically, it is again the issue of participation that is most commonly raised by the critics of these efforts, such as Michael McCloskey, chairman of the Sierra Club:

> *Few of the proposals for stakeholder collaboration provide any way for distant stakeholders to be effectively represented. While we may have activists in some nearby communities, we don't have them in all of the small towns involved. It is curious that these ideas would have the effect of transferring influence to the very communities where we are least organized and potent. They would maximize the influence of those who are least attracted to the environmental cause and most alienated from it.* (High Country News, 1996)

Also, collaborative groups, as part of their need for consensus in decisionmaking, may encourage "lowest common denominator" decisions, and the focus of most groups is not sufficiently broad because these efforts are rarely linked to river basin management programs (Rieke and Kenney, 1997). These concerns about adequacy of representation, the locus of decisionmaking authority, the processes of decisionmaking, and the adequacy of focus are all ultimately questions of governance. Whether or not they are factually accurate in the case of watershed initiatives, they do provide further evidence of the difficulty in crafting efficient, equitable, and universally acceptable mechanisms of governance.

Other emerging decisionmaking tools are currently at work in the West, changing the way resource management decisions are made and responding to and raising additional issues in resource governance. Prominent examples include the proliferation of alternative dispute resolution (ADR) devices in environmental conflicts and the use of adaptive management, mentioned in foregoing sections, to deal with complex problems. Both of these tools bring much needed pragmatism and action to management efforts, responding to and indirectly modifying deficient arrangements for resource governance. Specifically, ADR is a tool for addressing the high transaction costs (e.g., delays), narrow focus, and frequently zero-sum nature of many decisionmaking processes, especially in the judicial arena, although it has been occasionally criticized as improperly shifting the responsibility for decisionmaking (Bacow and Wheeler, 1984).

# *The CALFED Process: A Model for Resolving Complex Water Disputes*

The Bay-Delta region of California, the largest estuary in the West, is an intricate web of waterways created by the blending of the San Francisco Bay with the confluence of the Sacramento and San Joaquin Rivers (CALFED Bay-Delta Program, 19xx). The significance of this resource can hardly be overstated. "The Delta provides forty percent of the state's drinking-water supplies, serving over twenty million people in northern and southern California. The Delta also provides irrigation for 200 crops, including forty-five percent of the nation's fruits and vegetables" (Rieke, 1996). This 738,000-acre area of channels, sloughs, and islands is critical habitat for more than 120 fish and wildlife species and provides irrigation water for more than 4 million acres of farmland (CALFED Bay-Delta Program, 1997a).

Water quality standards in the Bay-Delta are established by the State Water Resources Control Board pursuant to the Clean Water Act. The Board had failed in several separate efforts over more than a decade to adopt a water quality plan to stem declining fish populations in the Bay-Delta and its tributaries which could be approved by the EPA (Rieke, 1996). In 1992, California Governor Pete Wilson brought together several state agencies with regulatory responsibility for the Bay-Delta to form the Water Policy Council (CALFED Bay-Delta Program 1997a). In September 1993, the Federal Ecosystem Directorate was created to coordinate related federal activities in the region. In June 1994, the Water Policy Council and the Federal Ecosystem Directorate joined to become CALFED.

CALFED was created as a means of bringing together representatives of agricultural, business, environmental, and urban concerns—all in an effort to guarantee more reliable water supplies and improved water quality for the environment, cities, and farms. By the end of that year, CALFED, in cooperation with these diverse interest groups, had drafted interim Bay-Delta water quality standards and created a state/federal work group to coordinate operations of the State Water Project and the federal Central Valley Project (CALFED Bay-Delta Program, 1997a).

In December 1994, Governor Pete Wilson, Secretary of the Interior Bruce Babbitt, and EPA Administrator Carol Browner announced that CALFED had reached a final agreement. This agreement called for increased fresh water flows for the Bay-Delta—an additional 400,000 acre-feet per year in normal years and 1.1 million acre-feet per year in critically dry years (Rieke, 1996). To provide greater certainty for agricultural and municipal supplies, any additional water needed due to additional endangered species listings must be met by water purchases financed with federal funds and undertaken on a willing seller basis.

Essentially, agricultural and municipal users are assured that additional water needs for endangered species purposes will not be through regulatory reallocations of water (Rieke, 1996).

In June 1995, CALFED launched the CALFED Bay-Delta Program to develop a long-term, comprehensive solution to Bay-Delta problems (CALFED Bay-Delta Program, 1997a). Whereas CALFED established the goals to be

(See "CALFED," next page)

***CALFED (continued)***

to San Diego, and frequent public technical workshops in Sacramento, have been a cornerstone of the process (CALFED Bay-Delta Program, 1997b).

Phase I of the CALFED Bay-Delta Program's three-phase process was completed in fall 1996. Three alternatives designed to comprehensively address Bay-Delta problems were developed with the benefit of significant public input. Each alternative addresses water use efficiency measures, ecosystem restoration, water quality protection, and levee improvements. Each also includes a range of storage options but differs in how it conveys water. During Phase I, 14 community meetings and 7 technical workshops were held to gather public input and additional scientific peer review (CALFED Bay-Delta Program, 1997b).

Phase II, which is underway, involves a six-step process leading to selection of a final preferred alternative in fall 1998. Extensive public participation will extend throughout this environmental impact statement/ environmental impact report process. Formal public hearings will follow the release of the Draft Programmatic environmental impact statement/ environmental impact report during Phase II (CALFED Bay-Delta Program, 1997b).

Phase III, site specific project analysis and implementation, will begin in late 1998 and last for decades.

It is estimated that $8 to $10 billion over 20 years is necessary for completion of the Bay-Delta recovery—$2 billion for ecological restoration, $1 billion for water quality improvements, $1.5 billion to improve system integrity, and the balance to establish a reliable water supply. Approximately $1 billion has been committed with $600 million from a California bond measure, $340 million from the federal government, and $60 million from private sources, including urban water districts.

CALFED and its successes to date are very impressive in light of the complexity and diversity of issues to be resolved. Most noteworthy is the extensive public participation that has occurred throughout the process.

Betsy Rieke, who, as Assistant Secretary of the Interior for Water and Science, managed the negotiations leading to the Bay-Delta Accord, summarizes some of the lessons learned.

> *(O)pen, inclusive, and collaborative processes are critical to decisions that will have a reasonable shelf life. Such processes do not mean that the decisions entrusted by law to federal officials are to be delegated to a group decisionmaking process. Rather, such processes assure there will be a genuine search for alternative solutions that provide mutual gains whenever possible. . .. The Bay-Delta experience also demonstrates that collaborative processes alone—regardless of how inclusive and well managed they are—often will not guarantee that long-term, national values receive adequate protection. Water users frequently need external incentives to put water on the table for environmental protection—whether those incentives are federal mandates, federal dollars, or something else. Absent the mandates, of the Clean Water Act and the ESA, there would be no Bay-Delta agreement and, therefore, no enhanced protection for the natural resources in that system (Rieke, 1996).* **#**

Adaptive management potentially accommodates a need for more immediate, broadly focused, and science-based management in many policy areas characterized by technical uncertainty (Lee, 1993). On the other hand, adaptive management may not be easily integrated with existing budgetary practices and may place undue faith and responsibility in the hands of scientific decisionmakers.

## Navigating the Road Ahead

Recent experience with water markets and watershed initiatives, among many other efforts, provides evidence that new institutional problemsolving tools are carving a niche in the traditional governance arrangements for western water resources. In general, both strategies have proven themselves to be useful tools that should be utilized further; however, they also are clearly not panaceas for all problems of resource governance. The sobering truth is that no panacea exists, and the rapidly growing demands on western water resources continue to pose a formidable challenge to our capacity for institutional change. Solving the water problems of the West, including the twin governance problems of decisionmaking gridlock and the fragmentation of government, will require the skillful development and application of a variety of problemsolving tools. Market-based and collaborative strategies based on voluntary action, positive incentives, and political viability are currently enjoying broad and significant success (though still with some detractors).

These new strategies appear to be strongly conducive to success, where institutional arrangements used in the past to promote river basin management were largely viewed as failures. This is critical, given the largely unmet need in the West and elsewhere for basin level planning process despite more than a century of experimentation (Rieke and Kenney, 1997). Efforts to force or encourage divergent agencies and political jurisdictions together for the purpose of regionally integrated resource management have often failed, partly because of the lack of support for these efforts. Similarly, strong forces at work promoting, nurturing, and protecting the status quo have not been acknowledged. While fragmentation of authority and accountability for integrated regional resource management clearly hinders problem-solving efforts in the West and elsewhere, fragmentation and specialization are central elements of "interest group governance"—the dominant mechanism for public policymaking in the United States for the last half-century, as noted earlier (Lowi, 1979). Consequently, the resolution of the West's water problems is to some degree, for better or worse, linked to our larger efforts to improve the quality of government in the United States.

Fortunately, there is some reason to believe that we may be moving beyond the self-imposed limitations on our ability to effectively govern the use of natural resources. Research suggests that a general shift in governance approaches is currently under-way in this country, moving away from the interest-group governance mode (featuring a substantively narrow and geographically broad focus) to a "civic governance" mode (featuring a substantively broad and geographically situational focus).[12] In the context of western natural resources management, the phenomenon of "civic environmentalism" is best illustrated by the growing recognition that issues of water supply, water quality, environmental restoration, and community stability must be approached in a more integrated and comprehensive manner and in a manner that respects the unique physical, political,

[12] In their terminology, the continuum of substantive focuses ranges from narrow to broad, while the continuum of geographic focuses ranges from universal (i.e., uniform policies in all regions) to more situational approaches (i.e., region-specific problemsolving approaches). This leads to a four-part scheme of governance modes, including "interest group governance" and "civic governance" (as explained above), as well as "rationalist governance" (substantively broad and geographically universal) and "populist governance" (substantively narrow and geographically situational).

and socioeconomic qualities of a given region. This provides an excellent basis for addressing the full spectrum of western water issues and improving the mechanisms of governance.

## *Meeting Obligations to Indian Nations and Tribes*

Indians and Indian tribes possess vested rights to water sufficient to provide a homeland. The Supreme Court's opinion in the 1908 case, *Winters* v. *United States* (207 U.S. 564 (1908)), remains the foundation of Indian water rights. At issue was the claim to use of water from the Milk River in Montana by the Gros Ventre and Assiniboine Indians on the Fort Belknap Indian Reservation as against upstream non-Indian appropriators. The court recognized the "command of the lands and the waters" previously held by the tribes and the concession they had made to stay within the limits of the reservation, exchanging their nomadic life for a pastoral one. Water sufficient to support this pastoral life must have been reserved by this agreement between the U.S. and the tribes, determined the court.

In 1963, the U.S. Supreme Court strongly reaffirmed the existence of tribal reserved water rights, this time in the context of the lower Colorado River.[13] The existence of these rights dates at least from the creation of the reservation, stated the Court. It then established a standard upon which tribal water rights reserved for agricultural purposes could be quantified: the amount of water needed to irrigate all "practicably irrigable acreage" on the reservation.

A major challenge for the federal government is to develop a strategy that results in Native Americans being able to benefit from the *Winters* doctrine[14] and other water rights. Many claims remain unquantified, and quantified and unquantified claims in some instances have not been put to beneficial use because of lack of funding for water projects. In many cases, the sources of water available to satisfy tribal rights are already fully appropriated and used. Particularly when senior tribal rights have not been adjudicated or otherwise quantified, states are reluctant to reduce uses by junior appropriators in favor of senior tribal uses. While the 1973 National Water Commission recommended that all *Winters* rights be adjudicated, we are much more cognizant of costs and limitations of large-scale water adjudications than we were at that time. This policy was actively pursued in the 1970s; and while some *Winters* rights have been quantified, adjudication has not delivered the anticipated "wet" or usable water to the tribes.

In addition, for many tribes the issue is not simply the quantification of their rights. As a matter of politics, new sources of water must often be identified to satisfy tribal rights and to allow junior non-Indian uses to continue. Increasingly, water issues involve complex environmental issues such as

[13] In *United States* v. *Adair*, 723 F. 2d 1394 (9th Cir.), *cert. denied*, 467 U.S. 1252 (1985), the Ninth Circuit held that the Klamath Tribe's treaty intended to reserve water necessary to support the hunting and fishing activities relied on by the tribe. The Ninth Circuit also upheld the existence of a reserved right to support the fishery on the Colville Reservation (*Colville Confederated Tribes* v. *Walton*, 752 F.2d 397 (9th Cir. 1985)). And the Washington Supreme Court upheld a decision in the Yakima River adjudication, finding a reserved water right for "the minimum instream flow necessary to maintain anadromous fish in the [Yakima] river, according to annual prevailing conditions" (*State Dep't of Ecology* v.

(continued...)

[13](...continued)

*Yakima Reservation Irrigation District*, 850 P.2d 1306 (Wash. 1993)). The Wyoming adjudication, on the other hand, found that the Wind River Tribes could not claim reserved rights on the basis of fisheries maintenance.

[14] The *Winters* doctrine provides that the establishment of an Indian reservation impliedly reserves the amount of water necessary for the purposes of the reservation *(Winters* v. *United States)*.

the preservation of endangered fish, so that tribal issues are interrelated with larger basinwide issues and must be addressed in this context. The long, bitter, and ongoing history of efforts to build the Animas-La Plata Project in Colorado illustrates the complications encountered in redressing past injustices to Native American tribes.

## Water Rights Settlements

In the late 1970s, tribes began to seek alternative ways to assert their rights. As of the end of 1996, 15 tribes have negotiated water rights settlements which have been ratified by the Congress, and 1 tribe has negotiated a settlement not requiring congressional action. Another 19 were in settlement negotiations. Negotiations offer the tribes several potential advantages over adjudication:

- Negotiated settlements may be faster and cheaper compared to adjudications.

- Tribes can tailor the application of the *Winters* doctrine to specific requirements of reservations and surrounding areas, eliminating some of the major legal uncertainties about the use of the water and providing means to benefit from the now quantified water. For example, settlements may specify the array of purposes for which water may be used and may allow some form of off-reservation use. The settlement may include provisions enabling tribes to directly secure supplies of water or to provide for water delivery and use systems.

Settlements increase the chances that the tribes will see wet water because the agreements can link rights (and their forbearance) to financial packages which enable tribes to develop their water. However, settlements also present formidable problems because they are ad hoc agreements that generally require congressional approval and financial support from federal and state governments, and they likely will require judicial recognition to be effective against all water users on or in a given stream or basin.

Despite the demonstrated benefits of settlements, the settlement process has slowed dramatically since the early 1990s, due in part to the way in which the Congress has chosen to account for settlement funds under its budget balancing efforts. The money to implement the federal share of Indian water rights settlements has traditionally come from the Bureau of Indian Affairs (BIA) budget, competing within a limited budget with other priority programs, and, in the view of many individuals and interests, including Secretary Babbitt, this is unacceptable. BIA's budget is not large enough to accommodate the large cost of settlements without severely affecting Indian education and health programs. Interior is currently exploring other avenues of funding, such as Reclamation appropriations and federal hydropower revenues.

## Water Marketing

Water marketing may provide an opportunity for tribes to utilize their resources until infrastructures can be built within the growing tribal communities and to provide water during the interim to off-reservation water-short communities. Discussions of Indian water marketing maintain a firm distinction between permanent sales and leases of Indian water rights. The Secretary of the Interior must consent to any title transfer of trust property; however, except for the statutory leasing authorizations contained in specific Indian water rights settlements, the Secretary of the Interior's authority to approve such leases is a subject of substantial debate. Many western states oppose tribal water marketing, however, as inconsistent with *Winters* and assert the authority to approve any changes of use occurring within their boundaries. Basic notions of fairness, as well as economic efficiency, demand that tribes be given the same opportunities to benefit from the use of their water resources as are available to other water rightholders. If legal and policy issues are

addressed, tribal water rights could be marketed at least within the state within which the reservation is located and even interstate. Most tribal water rights settlements have allowed restricted off-reservation marketing.

## Tribal Self-Management

Tribes contend that efforts to become more self-sufficient have been eroded by recent Supreme Court precedents and by Congress. The Endangered Species Act (ESA) is an example of such erosion, although the issue is complex. The ESA has been upheld by some courts as an exercise of Congress' plenary power over Native American tribes by making actions on reservations impacting protected species subject to control under the ESA. At least one tribe has used the ESA effectively to increase flows to preserve fish central to the tribe's existence. The Pyramid Lake Paiute Tribe, Nevada, relied on the ESA in response to a 1983 Supreme Court decision which refused to reopen a decree on the Truckee River, which feeds Pyramid Lake. The decision thus precluded the tribe from asserting reserved rights to flows to sustain the cui-ui, a federally listed endangered species. A federal court subsequently held that the ESA required Reclamation to operate an upstream reservoir to protect the species. This precedent enabled the tribe to play a major role in the congressional settlement of many of the disputes in the Truckee-Carson basin and in the implementation of the legislation. Conversely, in the Colorado River basin, some tribes have objected to the application of the ESA to tribes because compliance may be inconsistent with the construction of new and expanded tribal irrigation projects. For example, on the San Juan River in New Mexico, the completion of the Navajo Indian Irrigation Project has been delayed, pending years of studies of the effects of depletions on endangered fish downstream. In 1997, the Secretaries of the Interior and Commerce signed an order directing their agencies to apply the ESA in a manner least intrusive to the rights of tribes to use their natural resources.

Sustainable development requires that tribes play a major role in water use decisions affecting their lands. Many Native American tribes are actively engaged in charting their own future, and water allocation and management play a large role in this. Tribes seek the resources and technical assistance they need to improve management capabilities and to exercise the authority they already have through tribally developed programs or through implementation of federally developed programs.

## Indian Irrigation Projects

There are 77 federally authorized and funded Indian irrigation projects in the West, with a total potential for irrigation of almost 4 million acres. However, as reported by BIA (1997):

> *Because Indian irrigation projects did not receive a large outpouring of political and, therefore, fiscal support, many of the projects were never finished or fell into disrepair. The BIA's shift in funding in the mid-1970s, in combination with a number of other factors, all but eliminated operation and maintenance funds; the consequent disrepair of the facilities has been a source of increasing conflict in recent years as both Indians and non-Indians find it difficult to irrigate their crops with systems that 'leak like a sieve*.'

The BIA further states that,

> *It is critical that a review of these systems and selective rehabilitation and betterment be undertaken soon for a number of reasons. First, as Congressionally authorized projects, federal agencies have a duty to complete them so as to fulfill the intent of Congress with respect to tribes. Moreover, the protection of tribal water resources and the development of tribal economies is central to the trust responsibility. Further, it is essential from the standpoint of certainty that western water users be apprised*

# *Tribal Water Rights Settlements*

Water is perhaps the most valuable tribal resource remaining and is one of the most significant potential forces of change. The potential size of tribal water rights should not be underestimated.

> *For example, water rights claims of the Missouri River basin tribes could total more than 19 million acre-feet, or approximately 40 percent of the average annual flow of the Missouri. As of 1995, there are more than 60 cases in courts involving the resolution of Indian water rights claims. The total amount of water potentially involved in these claims ranges from 45 million to over 65 million acre-feet . . . [i]n Arizona, for instance, 19 Indian reservations account for 20 million acres (28 percent) of the state's land base. Experts have estimated that the water entitlements of Arizona tribes, many of which remain to be quantified, may surpass the state's water supplies.*

Since 1982, at least 15 water rights settlements have been ratified by the Congress. These settlements are summarized in table A.

Table A
(Source: National Research Council, 1996)

| Tribe | Location | Acre-feet per year |
|---|---|---|
| Ak-Chin Indian Water Rights Settlement Act | Arizona | 85,000 |
| Colorado Ute Indian Water Rights Settlement Act of 1988<br>(Ute Mountain Ute and Southern Ute Tribes) | Colorado | 92,000<br>39,900 |
| Confederated Tribes of the Warm Springs Reservation | Oregon | |
| Fallon Paiute Shoshone Indian Tribes Water Rights Settlement Act of 1990 | Nevada | 10,588 |
| Fort Hall Indian Water Rights Act of 1990 | Idaho | 581,031 |
| Fort McDowell Indian Community Water Rights Settlement Act of 1990 | Arizona | 36,350 |
| Jicarilla Apache Tribe Water Settlement Act of 1992 | New Mexico | 40,000 |
| Northern Cheyenne Indian Reserved Water Rights Settlement Act of 1992 | Montana | 91,330 |
| Salt River Pima-Maricopa Indian Community Water Rights Settlement Act of 1988 | Arizona | 122,400 |
| San Carlos Apache Tribe Water Rights Settlement Act | Arizona | 77,435 |

(See "Tribal Rights," next page)

***Tribal Rights (continued)***

| Tribe | Location | Acre-feet per year |
|---|---|---|
| San Luis Rey Indian Water Rights Settlement Act of 1988 | California | 16,000 |
| Seminole Indian Land Claims Settlement Act of 1987 | Florida | — |
| Southern Arizona Water Rights Settlement Act | Arizona | 66,000 |
| Truckee-Carson/Pyramid Lake Water Rights Act | Nevada (California) | 520,000 |
| Ute Indian Rights Settlement Act of 1992 | Utah | 481,000 |
| Yavapai-Prescott Indian Tribe Water Rights Settlement Act of 1994 | Arizona | 1,550 |

Negotiated settlement of tribal water claims, as opposed to adjudication through the courts, has some advantages. Through settlement, states can protect water users who have been previously granted water rights through state appropriation systems, the federal government can fulfill its trust obligation to tribes, and the tribes can turn "paper" water rights into wet water rights which can often be marketed to enhance economic development and self-sufficiency. Most importantly, all parties involved can avoid costly litigation.

However, negotiated settlements are not an easy solution. They rely on the willingness of parties to negotiate. Delays and political maneuvering are often considerable. Settlements generally must be ratified by the Congress and, in most instances, need judicial recognition to be effective. Most importantly, settlements generally rely on large infusions of federal funds to provide additional water for tribes without damaging the rights of other water users. Federal budgetary concerns will probably restrict funding of new water settlements and project-based solutions. Accordingly, future negotiators will have to be even more creative.

There are at least 20 pending Indian water rights settlements being negotiated, many of which have been prompted by the specter of litigation or general stream adjudications.

As of 1997, Indian water rights negotiations are shown below.

| Tribe | Location |
|---|---|
| Pueblos of Nambe, Pojoaque, San Ildefonso, and Tesuque | New Mexico |
| Pueblos of Zia, Jemez, and Santa Ana | New Mexico |
| Blackfeet | Montana |
| Crow | Montana |

(See "Tribal Rights," next page)

***Tribal Rights (continued)***

| Tribe | Location |
|---|---|
| Shoshone-Paiute Tribes of the Duck Valley Reservation | Nevada, Idaho, and Oregon |
| Fort Belknap | Montana |
| Gila River Pima-Maricopa Indians | Arizona |
| Pueblos of Acoma and Laguna | New Mexico |
| Las Vegas Paiute | Nevada |
| Navajo, Hopi, San Juan Southern Paiute, and Zuni | Arizona, New Mexico (Utah) |
| Lummi | Washington |
| Nez Perce | Idaho |
| Big Pine Bend of Owens Valley Paiute Shoshone Indians | California |
| Chippewa-Cree | Montana |
| Shivwits Band of the Paiute Indians | Utah |
| Soboba Band of Luiseno Mission Indians | California |
| Taos | New Mexico |
| Confederated Salish and Kootenai Tribes, Flathead Reservation | Montana |
| Turtle Mountain Chippewa Tribe | Montana |
| Zuni | New Mexico |
| Klamath | Oregon |

*of the potential volumes of tribal water involved as their projects resume functioning. For those tribes who choose to discontinue to irrigate on a large scale, the mechanism of tribal water marketing could free up large supplies and become a valuable source for environmental, agricultural, hydropower, municipal, and industrial uses* (BIA, 1997).

### Basic Water Supply and Sanitation Facilities

The provision of basic domestic water supply and sanitation facilities for Indian reservations is a significant challenge. Tribal lands have historically lagged far behind the rest of the nation in basic water supply and sanitation facilities. In 1988, the Environmental Protection Agency (EPA) surveyed water supply for tribal lands and reported that

> *. . .summer water shortages and limited storage capacity are common problems on many Indian reservations. Except for the Arizona tribes on the Colorado River and in the mountains, most of the tribes experience seasonal water shortages.*

EPA also reported that tribal drinking water systems show higher rates of violation for microbial standards than do nontribal systems nationwide. However, these data are collected only for water systems serving 25 or more persons. It is estimated that 650,000 Native Americans are served by water systems serving fewer than 25 persons. Little systematic information is available, therefore, concerning the quality of domestic water used by the vast majority of Native Americans living on reservations (EPA, 1988).

From 1960 to 1995, the Indian Health Service provided water and sewer systems for more than 200,000 Indian homes. However, in 1997, the Indian Health Service estimated that more than 20,000 Indian homes still do not have basic water and sewer systems and that many times more than this require significant upgrades to meet modern standards. Currently, the Indian Health Service estimates that more than $600 million would be required to address these deficiencies in sanitation facilities (Indian Health Service, 1996).

## *Environmental Protection and Restoration*

### Restoring Aquatic Ecosystems

The protection of fish and wildlife habitats, one of the most difficult problems in water management, is often the driving force in efforts to develop new basin and watershed protection strategies. Fish and waterfowl protection mandates are at the heart of four of six river basin studies prepared for the use of the Commission—the Sacramento-San Joaquin, Columbia, Platte, and Truckee Carson—and are playing an increasing role in the Colorado River and the Rio Grande.

The emphasis on the protection of fish and migratory waterfowl is one of the most dramatic changes in federal water policy since 1973 and is leading to a more holistic focus on the restoration and maintenance of healthy aquatic ecosystems. The 1973 Commission emphasized the incorporation of fish protection measures and flow release schedules into new projects, rather than the restoration of existing degraded systems. However, the events of the past 20 years have rendered this focus outdated—a key issue today is the potential reoperation of existing projects to help restore aquatic ecosystems, as was noted in foregoing sections.[15] The evolution of Reclamation's budget illustrates this shift in priority. Reclamation's fiscal year total budget for 1998 is $948.3 million. The

[15] The importance of ecosystem integrity has been a central focus of recent water policy reviews and recommendations.

Water and Power Resources account gets the largest share—$666.4 million—but this represents a 12-percent decrease from the previous year. Facility operation and maintenance is budgeted at $275 million, with about $96.1 million for dam safety. The new Water and Energy, Fish and Wildlife, and Land Management account is budgeted at $422.3 million. Only about $120 million is allocated to project completion; the rest is for ecosystem restoration, especially in the Bay-Delta and Central Valley of California, and for fish recovery and pollution reduction projects.

The construction of dams and the diversion of water from river systems or basins have contributed to the decline of historic natural fish populations in many river basins throughout the West. Dams and water diversion patterns have also increased predation, reduced wildlife habitat, and increased pollution. The lowered Mono Lake levels caused by transbasin diversions in California, the loss of whooping crane habitat along the Platte River in Nebraska, and the low and toxic volumes of water entering the Stillwater Wildlife Refuge in Nevada are examples of nationally prominent conflicts between consumptive use and wildlife habitat maintenance. Impoundments and diversions are not the sole source of declining fish runs; land use and forestry practices in riparian corridors, point and nonpoint source discharges, and natural weather cycles also contribute to the problem.

The immediate dilemmas facing modern water managers concern the preservation of existing native fish species and wildlife habitats, as well as the restoration of degraded habitats to increase their productivity. But there is also a growing recognition that the development of ecological baselines and the maintenance and restoration of healthy aquatic ecosystems are the best ways to avoid the bitter fish-versus-diversion conflicts that now pervade the West. There are three primary reasons for this. First, the ESA makes protection of listed fish and wildlife an absolute priority. The ESA directs the Fish and Wildlife Service (Service) or the National Marine Fisheries Service of the Department of Commerce to list species, subspecies, or distinct populations of fish and wildlife as threatened or endangered; the difference reflects the degree of extirpation risk. Once a species is listed, federal agencies or permittees may not take any action likely to jeopardize the continued existence of the species, including habitat destruction or modification. Second, the ESA applies to existing activities as well as to future ones. Third, there is increasing recognition that there are few "natural" aquatic environments to preserve. More and more, the emphasis is on the restoration of degraded systems.

## Protecting Water Quality

Sustainable development and management requires that we maintain streams and aquifers capable of supporting a broad range of human and ecosystem functions. In general, the quality of the West's waters is good, measured by the ability to support fish populations, human contact, and a wide variety of human and commodity production uses. EPA's *Water Quality in the West* report describes the majority of the West's waters as having "generally good" water quality, adding that, however, "in many instances it suffers from varying degrees of degradation" (EPA, 1998). This conclusion is encouraging but is based on a summary of the indices used to measure water quality. We rely on indirect measurements—temperature, dissolved oxygen, fecal coliform bacteria, dissolved solids, nitrates, phosphorus, and suspended sediment—to evaluate water quality. However, these indices do not fully reflect the status of the West's rivers or riparian areas. Measurement is further complicated because natural and anthropogenic factors interact in complex ways to affect surface water quality, and the indices do not reflect the problem of inadequate data. We do not have a comprehensive inventory of the extent of pollution in rivers; we have fragmentary information that can only provide a snapshot of water quality issues.

# *Dam Removal: A New Option*

Removal of existing dams for environmental purposes is an idea that is being actively investigated in a number of locations in the United States. In Michigan and Wisconsin, a basinwide study of the Menominee River associated with FERC license renewal has resulted in an agreement to modify operations at some dams and to remove three dams—Sturgeon Hydro in Michigan and Pine Hydro and Woods Creek in Wisconsin. Issues identified to date include sediments, fisheries, wetlands, waterfowl, and contaminants. The agreement calls for the removal of the three dams in steps, with the first being removed 5 years after the agreement is approved, the second 7 years after, and the last 29 years after FERC approves the agreement.

On the Olympic Peninsula in Washington state, a cooperative study by the National Park Service, Reclamation, the Corps, and the Service has led to a proposal to remove the two dams on the Elwah River. These dams (Glines Canyon and Elwah) currently are used for hydropower generation and were privately constructed in the early part of this century. Removal should help restore a number of anadromous fisheries in the river. Additionally, the anadromous fish resource is of cultural significance to the Lower Elwah S'Klallam Tribe, and its restoration would uphold the federal trust responsibility. The environmental impacts analysis identified silt and the control of the silt deposits behind the dams as significant issues to be addressed in removal of the dams.

Finally, and most speculatively, a study is underway to evaluate removal of four dams on the Lower Snake River to help restore Snake River salmon stocks. The four dams (Ice Harbor, Lower Monumental, Little Goose, and Lower Granite) were constructed by the Corps in the 1960s and 1970s. The Corps is now examining if it is reasonable to remove the dams and what other actions may be necessary to restore the salmon. A significant question is whether the river, even with dam removal, can be restored to a fish friendly condition.

While removing dams has potential to significantly restore ecosystems, little experience exists anywhere with the consequences of removing an existing dam. Definitive answers to persistent questions of stream rehabilitation within the reservoir pool and silt impacts to the downstream reaches are not available and are not likely to be available until a removal is completed and impacts studied.

For the first time in history, FERC has denied a relicensing request for an operating hydroelectric dam and made the unprecedented recommendation that the 160-year-old Edward Dam on the Kennebec River near Augusta, Maine, be completely removed to help restore spawning habitat for nine migratory fish. The state of Maine, as well as the Departments of Commerce and Interior, has endorsed the recommendation. FERC conducted an independent analysis of three options—the status quo, keeping the dam but spending $10 million to build fish passage facilities, and dam removal—and found the latter to be the best and least expensive option as part of a comprehensive plan for developing and improving the Kennebec River basin.

Interior Secretary Babbitt has supported the recommendation, stating:

> *The Commission made a difficult but brave decision: that a river is more than the sum of its kilowatthours, that its potential energy goes far beyond any electricity it may generate. The Kennebec can once again stand as a model for the nation. Its true power will become self-evident in the many species of teeming anadromous fish that will soon swim and spawn there again, in the anglers who will inevitably seek them, and in the local sustainable sportfishing economy which will steadily grow up around those anglers and recreationists.* **#**

An important challenge for federal and state decisionmakers is to find ways to collect and synthesize the information that will enable them to formulate baselines against which adaptive management can be measured. The Sacramento-San Joaquin study found that, after years of research on the Bay Delta, a model of an undisturbed ecosystem the size of the Bay Delta did not exist, and the CALFED process has not established "the ecosystem baseline."

The primary regulatory focus of the Clean Water Act has been elimination of point source municipal and industrial discharges and toxic wastes. The assumption was that this would improve the quality of receiving waters. Today, the emphasis on biodiversity conservation has placed increased emphasis on defining the conditions for a healthy aquatic ecosystem. As states and the federal government struggle to decide how to protect endangered fish populations, river parameters are being set that make preservation of endangered and threatened native species the driving factor in all present and future water use decisions.

An eastern regional perspective is also reflected in the greater attention to point rather than nonpoint source reduction. Agricultural drainage water is exempt from the requirement to obtain a discharge permit when discharged through a point source. Additionally, farm runoff that is nonpoint source pollution is not subject to national technology-forcing standards, and states have considerable discretion in how they approach managing these nonpoint sources. Regulation of nonpoint sources is not required by the Federal Clean Water Act. A major future challenge will be to reduce nonpoint source pollution from irrigation, livestock production, and mining and timber production, as well from urban runoff, in an effective and affordable manner.

Ultimately, water quality cannot be separated from the general problem of the restoration and maintenance of healthy and productive aquatic ecosystems. We need to provide the incentives and regulations that prevent pollution at the source. However, controlling discharges must be coordinated with maintaining adequate streamflows and managing exotic species. We can no longer maintain the artificial separation between water quality and quantity. This requires maintaining national pollution standards, but also the recognition that basin and watershed entities must have some flexibility to apply and adapt them to local conditions.

## *Flood Plain Management*

Floods are an endemic part of the hydrologic cycle, but we have been unable to develop management policies that effectively reduce flood damage. Sustainable flood management is ultimately an important component of aquatic ecosystem maintenance and restoration. It requires the greater use of ecosystem functions, such as wetland and upstream retention, and greater efforts to prevent flood damages by discouraging high-risk uses of flood plains (Interagency Flood Plain Management Review Committee, 1994). Unlike ancient civilizations such as Egypt, which built their agriculture and social systems around periodic flooding, we treat floods as natural disasters to be prevented or mitigated to the maximum extent possible. The 1997 cycle of floods repeated a familiar pattern and elicited the traditional call for federal assistance to property owners damaged by flooding. Our characterization of floods as preventable natural disasters has led to unsustainable land use practices that need to be reversed in upstream watersheds and on flood plains.

Characterizing floods as natural disasters has made it difficult to recognize the need for periodic inundations on some river systems to maintain their historic natural productivity and their riparian zones. In the West, we have altered the natural flow cycles of most large rivers by impounding them for multiple uses. One major cost of reservoir construction, as the Commission was informed, is that river "productivity has . . . shifted riverine to lentic productivity associated with large reservoirs,

and the historic balance between retention and transport has been altered" (Grimm, 1997). Not only do we fail to recognize the ecosystem and economic benefits of seasonable flow regimes, but we engage in land use practices that exacerbate the magnitude and scale of flooding. Both urban development and rural land use practices have contributed to this problem (Minckley, 1997).

Since the 1930s, our approach to flood control has been to prevent floods by building large reservoirs to retain flows and subsequently release them at nonflood levels, and by investing in levees, dikes, and channelization to increase channel capacity in flood-prone river segments. For example, during the 1996-97 floods in California, outflows from the Folsom Dam on the American River were 252,000 cubic feet per second (cfs), compared to the normal outflow of 10,000 cfs. The dam prevented floodwaters from rising 10 feet above the levees in Sacramento (Western States Water No. 1183, January 17, 1997).

However, there is a growing dissatisfaction with our exclusive reliance on upstream storage and channel modification. The common theme in the modern flood control debate is the recognition that water and land management policies have increased the magnitude of floods and settlement of flood plains, and thus the amount of flood damages. In addition, flood plain management programs have not succeeded in mitigating flood losses in most situations. Multiple purpose dams have often increased downstream flooding by diminishing the channel's capacity to pass floods. They have also eliminated flood cycles that replenished stream systems and ecosystems. For example, the Elephant Butte Dam on the Rio Grande in New Mexico has increased flooding in El Paso by reducing flushing of the stream channel downstream. Sediment from bank scouring has combined with sediment loads from undammed tributaries to raise the bed level downstream. The net result is that, even though Elephant Butte Dam has reduced predam flows at El Paso by as much as 75 percent, small floods can do a great deal of damage (Collier et al., 1996). One of the lessons that the Commission learned from the Aquatic Ecosystem Symposium is summed up in a 1996 U.S. Geological Survey paper:

> *Floods are a key element in the future management of dams. Without periodic high flows, some channels downstream from dams will aggrade with sediment or narrow with overgrown vegetation. Two or three flood free decades may have been traded for more devastating floods in the future* (Collier, et al., 1996).

There are basically four ways by which humans adjust to floods. Unlike many other water programs, these approaches require the cooperation of all levels of government to implement.

1. We can bear the loss.

2. We can modify the loss burden by (1) emergency measures that remove humans from the path of a flood, or (2) redistribution of the loss through insurance or government-financed relief.

3. We can limit our susceptibility to damage by limiting land uses in the flood plain to those that are the least vulnerable to floods, by preserving the major flood channels, by designing structures to withstand floods, or by floodproofing buildings to the maximum extent possible.

4. We can confine water to the channel through levees and floodwalls, and we can minimize the scope of the flood by preserving wetlands and floodways.

Land use regulation is a relatively efficient way to minimize flood damage, but it is still easy to build in flood plains because few state or local governments pursue flood plain management aggressively.

# *"We'd Like to Make One Thing Perfectly Clear"*

Arthur C. Clarke's "third law" states that sufficiently developed technology is indistinguishable from magic. We seldom deal with technologies as dramatic as that in natural resource management. However, the Agriculture Research Service's (ARS) lab in Idaho has developed a simple technology with truly dramatic effects. The team has found that a dash of Polyacrylamide (PAM, a white powder) in furrow irrigation water virtually halts furrow irrigation-induced erosion. Contrasting untreated and PAM-treated runoff is like comparing a milkshake with bottled drinking water. In 3 years of ARS tests, erosion was reduced 80 to 99 percent (an average of 94 percent) using the application method adopted by Natural Resources Conservation Service as an interim standard (10 parts per million in advancing furrow streams, about 1 pound per acre). Drastic reductions in runoff P, N, BOD, and pesticides have also been documented. This research was initiated in 1991 to address the many problems associated with irrigation induced erosion, including:

- Sediment in irrigation return flows may cause water use impairment from sediment pollution and agrichemical transported by sediment, resulting in major water-quality degradation of several rivers in the western United States, harming fish and other aquatic life.

- Erosion reduces the agricultural productivity of the fields and causes off-farm damages. In southern Idaho, crop yield potential has been reduced by 25 percent due to 80 years of irrigation-induced erosion.

- Some irrigation districts spend more than $50,000 annually to remove sediment from drains.

ARS's initial research led to demonstration projects throughout the West sponsored by the Natural Resources Conservation Service, the University Cooperative Extension Service in several states, and major distributors of PAM. Some users believe continued use could cut down on the size of sediment basins needed—resulting in less maintenance and more productive land.

A by-product of PAM's use may be water conservation and increased yields. Because farmers can irrigate without the usual risk of erosion, PAM use also opens the door to new surface irrigation management. Longer furrows, higher flows, and shorter sets can be used without erosion and potentially still provide improved irrigation uniformity and less leaching of soluble chemicals and fertilizer to groundwater. PAM's ease of use has led to ready acceptance by farmers who were reluctant to adopt more difficult conservation measures. PAM (at $3.50-$5 per pound) is economical, requiring 3-7 pounds per acre to protect most crops all season.

Because of successes and its ease of use, growth of PAM use has been phenomenal. PAM's use grew from an estimated 50,000 acres during its 1995 debut to near 500,00 acres in 1996. Based on sales inquiries, the 1996 acreage of use could double or triple in 1997. An environmentally safe product, the industrial/governmental use in the U.S., including in municipal water treatment systems, is nearly 200 times the current use in agriculture. Most of that use is via water treatment processes that deliver effluent directly to riparian waters as contrasted with agriculture use where studies to date have not detected measurable losses to riparian resources. Research across the West is now looking at PAM application in sprinklers and dozens of other new ways to use PAM's remarkable properties to benefit agriculture and the environment.

As Bob Sojka and Rick Lentz, ARS soil scientists in Kimberly, Idaho, who initiated the PAM research, continue to say in regards to runoff from irrigated fields, "We'd like to make one thing perfectly clear." Farmers across the West are now doing just that. **#**

—Ron Marlow, Natural Resources and Conservation Service, Department of Agriculture.

Federal programs can also undercut those state and local efforts which do encourage more responsible use of flood plains. For example, in response to recent hurricanes, earthquakes, and floods such as the Mississippi valley floods of 1993, the federal-state cost sharing of Federal Emergency Management Agency disaster assistance programs for these events was raised from 75/25 to 90/10. As the Galloway Report (published by an executive task force following the 1993 Mississippi floods) observed, such a program establishes:

> *. . .an expectation of similar treatment in subsequent disasters and increases political pressure to provide a lower nonfederal share. This perpetuates the dominant federal role in recovery and increases federal costs.*

It also defeats "the fundamental purpose behind cost sharing, which is to increase the amount of local involvement, responsibility, and accountability" (Interagency Flood Plain Management Committee, 1994).

Federal water resource planners within and outside the Corps have long been aware of the limitations of over-reliance on structural flood control measures. Recent severe floods have prompted renewed interest in nonstructural flood control measures as an integral part of river basin flood management. The Galloway Report articulated a new vision of flood plain management that included two strategic goals: (1) reducing the vulnerability of the nation to the dangers and damages that result from floods, and (2) preserving and enhancing the functions of flood plains (Interagency Flood Plain Management Review Committee, 1994). The flood plain of the future includes much human activity, but the most vulnerable activities would be relocated to higher ground, and those who choose to reside and use flood plains without taking mitigation steps would assume more of the risks of flooding. Greater use would be made of natural retention areas, such as sloughs and wetlands, and other upstream runoff retention strategies to complement dams and levees.

## *Protecting Productive Agricultural Communities*

The changing West produces winners and losers, as population growth affects the nature of communities and increases the nonagricultural uses of water. Many communities are facing intense pressures to abandon long-established patterns of economic livelihood and culture. Urbanization and the division of large rural holdings into smaller, often second-home parcels, are changing the landscape and life of many western small towns. To aggravate matters, agricultural subsidies are being withdrawn, and market pressures are reallocating land and water to new uses.

Many of these western communities may, in fact, be practicing (or could practice) sustainable resource use with the appropriate encouragement. Farming and ranching practices can be, and in many instances are, maintained in an environmentally sound manner. When this is done, the landscape is maintained out in a manner more consistent with aquatic and terrestrial ecosystem conservation, as compared to piecemeal urbanization and suburbanization.

### Water Policy

It is difficult, however, for local leaders and water managers to preserve the historic nature and culture of local communities in the face of development pressure.

Water policies only indirectly affect growth patterns; and where they do have an effect, water policies have historically supported development. The limited role that water law and policy play in stabilizing rural communities is illustrated by the National Academy of Science's study of western

water transfers. *Water Transfers in the West: Efficiency, Equity, and the Environment* (NRC, 1992b) recognized that impacts on rural communities—such as "changes in the quality of community life, feelings of connectedness to the land, and a sense of control over an area's destiny"—are legitimate third-party effects of water transfers. However, the report did not indicate the process that would lead to community stability when water is reallocated, reflecting the long-standing social policy that government has no special responsibility to protect communities from the discipline of the market.

Western water law is based on the understanding that human needs often require water to be removed from streams and transported over long distances, often out of the basin of origin. This idea is expressed as a "policy of capture," which allows water to be removed completely out of its natural watershed, sometimes leaving little or none for those who may have need for it later (Bates et al., 1993). Various measures have been proposed to alleviate these impacts. The National Water Commission suggested that a transfer of water from one basin to another should be permitted only when it has been proven to be the lowest economic cost source of water supply and to have benefits that exceed all costs (National Water Commission, 1973). Others have suggested that areas of origin should be adequately compensated for their economic losses (MacDonnell et al., 1985), but such compensation would do little to address the social and cultural impacts that may result. Public utility law complemented prior appropriation because most water suppliers have assumed that they have a legal duty, as public utilities, to provide adequate supplies for all anticipated growth and in seasons of drought.

The insistence by many westerners that land and water are exclusive individual property rights with no community dimension means that the control of land and water is decentralized. Land and water are alienable property rights, and individual rightholders are generally free to respond to market pressures without regard to the impact of a decision to break up a parcel of land or transfer a water right on the surrounding community.

The historic acceptance of a duty—noted above—to provide the necessary water for unlimited growth has further acted to separate water from land use issues. The problem is exacerbated because land use controls have largely been delegated to the county and municipal level, except in a few states such as Oregon. Water allocation, however, remains primarily a state function. This historic separation of land and water law and policy is now changing. States are beginning to link more closely water supply and land use planning objectives, and these initiatives give local governments some ability, if they take advantage of it, to control the use of local water resources. In 1965, California enacted legislation—primarily in response to the rapid growth and conversion of prime agricultural land in the San Joaquin valley—that requires cities to have a firm water supply plan in place before large, new developments are approved. This limits the power of cities to approve new growth and defer the issue of the provision of an adequate water supply until a later date. An intermediate appellate court has also interpreted the California Environmental Quality Act to reinforce the duty to match growth to availability of water supplies. Further, California historically has refused to regulate groundwater use at a state level; but in recent years, the legislature has given individual counties the right to control exports.

## Community Influence

Communities typically do not control the allocation or reallocation of water—but state laws often provide local communities some leverage to influence water transfers. Most states have liberalized standing rules to allow nonwater rightholders to

# *New Approaches to Flood Management*

The 1994 report, *Sharing the Challenge: Floodplain Management Into the 21st Century*, was produced by an interagency task force created to deal with the 1993 Midwest flooding and recovery. One of the main recommendations of the report was to place a new emphasis on using nonstructural solutions for flood damage prevention; to look for opportunities to move people and structures out of frequently flooded areas or to reduce their vulnerability to flood damage, rather than using dams and levees to prevent the area from flooding.

Historically, nonstructural solutions to flood mitigation have been one of the tools employed in federal flood management programs. Below are listed some recent nonstructural projects undertaken by the Corps.

| Location | State | Description | Year |
|---|---|---|---|
| Allenville | AZ | Acquired 54 houses, replaced outside of long term | 1981 |
| Prairie du Chien | WI | Acquired 122 houses, 2 commercial structures | 1984 |
| Wilson Bridge | SC | Relocated six homes | 1984 |
| Sope and Proctor Creek | GA | Acquired and relocated 45 homes | 1986/ 1990 |
| Ardsley | NY | Floodproofed four commercial structures | 1989 |
| Malhuer Lake | OR | Raised 6.3 miles of railway | 1990 |
| East Brewton | AL | Acquired 19 commercial properties | 1993 |
| Williamson | WV | Floodproofed 54 homes | 1994 |

(Source: Corps, 1997)

These new approaches were emphasized immediately following the Midwest floods. More than 12,000 structures have been acquired or relocated, and more than 250,000 acres of flood-prone land have been acquired by state and federal agencies.

This new emphasis in flood mitigation has been formalized in law and federal programs through subsequent legislation:

Flood Insurance Reform Act of 1994
1996 Farm Bill
Water Resources Development Act of 1996
Crop Insurance Reform Act of 1996

(See "Floods," next page)

***Floods (continued)***

Recently, the White House issued guidance (Memorandum Executive Office of the President (dated February 18, 1997) that reflects the main principles of *Sharing the Challenge*. Its stated purpose is "to ensure the agencies fully consider relevant options, including nonstructural alternatives, during the evaluation and review of levee repair and reconstruction projects and associated restoration necessitated by the 1996 and 1997 floods." Its goal is "to achieve a rapid and effective response to life and property, while ensuring a cost-effective approach to flood damage mitigation and flood plain management and the protection of important environmental and natural resource values that are inherent to the long term and adjacent land."

The California Governor's Flood Emergency Action Team Report (May 1997) was prepared after the January 1997 floods, in part to guide improved flood response and recovery. It also reflected interest in and support for less traditional responses to flood recovery, in particular, the need to develop integrated planning to aid future flood response and recovery efforts consistent with joint state/federal long-term water resource management and environmental restoration goals. **#**

participate in water rights proceedings, but there is little substantive protection for community stability. Most states have the power to subject new appropriations to a public interest review, and this standard is now being extended to transfers. Statutes in California, Idaho, Montana, Nebraska, Texas, and Wyoming give state water administrators the power to take public interest considerations into account in transfers (Grant, 1987). A Utah court interpreted Utah's transfer statute to include public interest review *(Boham* v. *Morgan*, Utah, 1989). The Idaho Supreme Court has ruled that state law allows the Department of Water Resources to invite protests in change of place of diversion proceedings from third parties beyond those in the immediate area of the diversion, and this ruling was upheld on appeal.[16] A New Mexico trial court opinion held that a proposed change of water use from livestock and early season flood irrigation to a ski resort was invalid, even though there was no proof of any injury to vested rights. The court held that the transfer was contrary to the public interest because

> *. . .the Northern New Mexico region possesses significant history, tradition and culture of recognized value, not measurable in dollars and cents; the relationship between the people and their land and water is central to the maintenance of that culture and traditions and the imposition of a resort-oriented economy in the Ensenada area would erode and likely destroy a distinct local culture that is several hundred years old.*

The case was reversed on appeal because the New Mexico transfer statute at the time did not allow public interest considerations in transfers, and the New Mexico Supreme Court refused to hear an appeal *(Sleeper* v. *Ensenda Land and Water Association, New Mexico*, 1988). (New Mexico law now allows the public interest to be considered in transfers.) This case has led some to suggest that communities be given a veto over major water rights transfers (DuMars and Minnis, 1989). Public interest review can be supplemented by the public trust doctrine. Some states hold that vested water rights are subject to the public trust (*National Audubon Society* v. *Superior Court of Alpine County*, 1983). This judicially controlled doctrine permits a court to balance the environmental and consumptive values of a water use and, in some states, to require that consumptive uses of navigable waters be subordinated to ecosystem maintenance. Thus, transfers could be judicially invalidated because they are inconsistent with the public trust use of the water. However, the trust doctrine has not been extended beyond the protection of fragile ecosystems.

Communities can benefit from statutes that either revive the original idea that water rights were appurtenant to the land where the water was initially applied to beneficial use or that protect the area of origin of the water. The 1992 Central Valley Project Improvement Act is an example of a modern appurtenancy statute:

- Transfers in excess of 20 percent of a contracting agency's long-term space entitlement are subject to agency approval (§ 3405(1)).
- The amount of transferable water cannot exceed the average annual quantity delivered during the last 3 years of normal water delivery before 1992.
- All transfers of water out of the Central Valley Project service area are subject to a right of first refusal by the agencies within the project service area (§ 3405(1)(F)).

[16] *Hardy* v. *Higginson*, Case No. 92599 (District Court of the Fourth Judicial District of the state of Idaho, July 25, 1990), affirmed in part, rev'd in part 123 Idaho 485, 849 P.2d 946 (1993), upheld the power of the state engineer to impose conditions on diversions from the critical habitat of a candidate fish for listing under the Endangered Species Act.

# *High Stakes! Preserving Colorado's Great Outdoors*

When it comes to innovative funding mechanisms, Colorado voters showed great foresight when they chose to use the proceeds from the Colorado Lottery to fund a program to preserve Colorado's "Great Outdoors." The Great Outdoors Colorado (GOCO) program was approved by the voters in 1992 to protect wildlife and habitat and recreational resources, and to provide grants to state agencies, counties, and local and other entities to acquire and manage open space and parks.

To date, GOCO has invested $94 million in 791 projects throughout the state. The projects range from large, multiyear projects—such as the South Platte River Project to restore the river corridor, trails, and wildlife habitat—to smaller grants such as those to help the town of San Luis create its first park. The popularity of the GOCO programs is clear: it receives three times as many project requests as it can fund. To spread its resources as far as possible, GOCO encourages its grant recipients to leverage their money with partnerships and other sources of revenue.

As Colorado's population rapidly grows, creating suburban sprawl and filling the farm and ranchlands with ranchettes and second homes, communities throughout the state are seeking ways to preserve the quality of life in their areas, protect agricultural communities, provide wildlife habitat and corridors, and provide recreational opportunities. GOCO has provided planning assistance to these communities.

One recent example illustrates the remarkable changes taking place in Colorado. In the Gunnison valley, ranchers, environmentalists, and other local citizens watched with growing concern as the valley ranchlands and scarce riparian areas were divided, sold, and developed for second homes. They decided to put aside old animosities and take collective action before their valley turned into another Aspen. Over a period of years, they met, got to know each other better, determined their common goals, and worked out a plan to save their valley and keep the local ranchers in business.

Their plan is relatively simple: raise funds to purchase conservation easements on ranch and riparian properties and put those lands into permanent trusts so that they cannot be developed. The ranchers, already financially stressed, will get some cash as the conservation easements are purchased, and their taxes will go down because their land will no longer be developable. The coalition approached GOCO to help with funding. GOCO liked the fact that the plan was well thought out and had the support of the broad community (*Time*, 1997) and awarded a $2 million grant to fund the Gunnison Legacy project. It is now up to the local sponsors to raise the rest of what they need and make their plan work. **#**

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# *Public Trust Doctrine—Its Role in Protecting Water Resources*

In the past 25 years, the legal concept of "public trust" has played a significant role in western water management. The public trust concept has some of the oldest roots of any legal doctrine, tracing its origin to the ancient Romans. Public trust rights were set forth almost 1,500 years ago as a part of the Corpus Juris Civilis, promulgated between 529 and 534 A.D. by Roman Emperor Justinian. Roman public rights in water and the seashore were generally unrestricted and common to all. Generally speaking, the public trust doctrine involves:

> *. . .that aspect of the public domain below the low water marks on the margins of the sea and the great lakes, the waters over those lands, and the waters within rivers and streams of any consequence. . .. Traditional public trust law also embraces parklands, especially if they have been donated to the public for specific purposes; and, as a minimum, it operates to require that such lands not be used for nonpark purposes* (Sax, 1970).

In the United States, the public trust doctrine has been closely associated with the state sovereign ownership doctrine, which asserted that when a British Colony or U.S. territory achieved statehood, the state received immediate ownership of certain lands and waters previously owned by the Crown or the U.S. government. "These natural resources are viewed as being held by the state in a fiduciary capacity, for the benefit of the members of the general public" (Beck, 1991). In other words, the significance of these public resources creates a public interest in how these resources are used, and this public interest rises to the level of a trust responsibility. It is uncertain at what point private use of a public resource violates this trust responsibility.

The first application of the public trust doctrine in the United States came in *Illinois Central Railroad* v. *Illinois* (1892). The Illinois Central Railroad fought the repeal of a statute that granted the railroad ownership of submerged lands in Lake Michigan. Ownership was given in consideration for providing a percentage of profits to the state on monies made from docks and wharfs on these lands. The U.S. Supreme Court ruled that these lands were held in trust for Illinois citizens and therefore the state could not convey these lands in a manner inconsistent with this trust responsibility.

How this doctrine is applied today is highly controversial.

> *Three types of restrictions on government authority are often thought to be imposed by the public trust: first, the property subject to the trust must not only be used for public purposes, but it must be held available for use by the general public; second, the property may not be sold, even for a fair cash equivalent; and third, the property must be maintained for particular types of uses. The last claim is expressed in two ways. Either it is urged that the resource must be held available for certain traditional uses, such as navigation, recreation, or fishery, or it is said that the uses which are made of the property must be in some sense related to the natural uses particular to that resource. As an example of the latter view, San Francisco Bay might be said to have a trust imposed upon it so that it may be used for only water-related commercial or amenity uses . . . but it would be inappropriate to fill the bay for trash disposal* (Beck, 1991).

Modern expansion of the public trust doctrine came in *National Audubon Society* v. *Superior Court* (1983), more commonly known as the "Mono Lake" case, where the court applied the doctrine to water appropriation. For years,

(See "Public Trust," next page)

### *Public Trust (continued)*

Los Angeles had diverted water from Mono Lake tributaries, significantly affecting water quality and water quantity in the lake. The appropriations were challenged on the basis that they violated the public trust, and the California Supreme Court held that Los Angeles water rights are subject to limitation in order to protect the public right to water in Mono Lake itself.

> *Prior to National Audubon Society, however, courts had not applied the doctrine to limit diversions of water from navigable water courses. . .. [This] decision potentially allowed the state to reallocate water from private consumptive use to public instream uses. . .. Moreover, the court's decision did not suggest that these involuntary reallocations for public uses triggered compensation for a 'taking' under the state of federal constitution* (Weber, 1995).

In most states, hints of public trust considerations can be found in legislative or judicial requirements imposed upon state engineers, or their equivalent, when they are reviewing applications for water appropriations. Public trust ideals are reflected in mandating consideration of the effect of water allocation decisions on fish and game resources and on public recreational opportunities associated with streams, rivers, and lakes (Alaska Stat. 46.15.080 (1987) and North Dakota Cent. Code 61-04-06 (1993)). In other states, public trust doctrine ideals emerge from beneficial use definitions.

Beneficial use definitions have included appropriations of water for wildlife (*McClellan* v. *Jantzen*, 26 Ariz. App. 223, 547 P.2d 494 (1976), recreation, and fish and wildlife (American Bar Association, 1988)). Beneficial use consideration at the administrative level has essentially created instream flows for fish. In South Dakota, an appropriation application was denied because the waters in question were some of the most productive spawning grounds for fish, especially brook trout. The administrative denial was based on public interest in maintaining the present flow and temperature of the water for the fishery and outweighed the proposed use by the applicant (American Bar Association, 1989).

Still, the public trust doctrine is not firmly entrenched in American law for

> *[d]espite the plausibility of treating the statements in Illinois Central on the fiduciary obligation of a state as an expression of federal law, they have not been treated subsequently as binding on the states. Years later, the Supreme Court itself characterized Illinois Central as an application of Illinois law, and generally the state court decisions do not treat Illinois Central as binding upon them* (Beck, 1991).

Realizing this, some state legislatures have sought to limit their own public trust responsibilities. The Idaho legislature has specifically excluded the public trust doctrine from applying to management or disposition of state constitutional lands; appropriation or use of water; or the granting, transfer, administration, or adjudication of water or water rights as provided for under the constitution and water code, or under other procedure or law applicable to water rights in the states; and protection or exercise of private property rights within the state (*Water Strategist*, 1996).

Just how, or if, the public trust doctrine fits within the spectrum of state sovereign ownership is unclear. States apparently have broad discretion in interpreting their public trust obligations, and the extent to which they can limit these obligations is unsettled. **#**

Area-of-origin protection legislation developed in California prohibits the state from transferring appropriations when the transfer will deprive the county in which the water originates of water necessary for its development (California Water Code § 10505). A broader statute protects watersheds of origin and adjacent areas from the export of water to supply projects such as the Central Valley Project (California Water Code § 11460). Area-of-origin protection principle can be expanded to encompass river basin protection in appropriate circumstances. The California Delta Water Rights decision (*United States* v. *State Water Resources Control Board*, 1986) used the state public trust doctrine and state water quality law to extend area of origin protection law to both upstream and downstream diversions to protect water quality and fish and wildlife.

In recent years, rural communities have asserted their interests more aggressively, and these experiences provide some examples for communities who want to develop sustainable water use and growth plans. Control over their water resources is an important symbol of community. As water scholar Helen Ingram has written:

> *Strong communities are able to hold on to their water and put it to work. Communities that lose control over their water probably will fail in trying to control much else of importance* (Ingram, 1990).

In the early 1990s, for example, a diverse mix of residents of Colorado's San Luis valley successfully opposed a private company's proposal to pump and transport groundwater from their basin to faraway urban areas. Funded by a self-imposed tax, the locals were able to participate in water court proceedings that ultimately led to the defeat of the proposed water export (Bates et al., 1993). Water managers in Colorado's Arapahoe County ran into similar local opposition when they proposed a network of diversions, reservoirs, and pipelines to transport water from the Gunnison River basin on the western slope to the rapidly growing Front Range. In other western river basins, rural residents are finding the means to resolve water disputes outside the traditional channels. For example, irrigators and environmentalists hammered out an innovative instream flow protection scheme for the Clark Fork River in Montana as an alternative to costly and time-consuming litigation. The coalition's plan was later adopted by the state legislature and now guides water management in the upper basin (Snow, 1996).

These and many other stories of rural communities organizing around water offer support for the statement that,

> *. . .[b]ecause water is a highly emotional issue closely bound up with ideas of community, self-determination, and survival, it prompts a committed, group response that is a necessary ingredient to successful economic development* (Brown and Ingram, 1987).